Iron and Steel ENGINEER

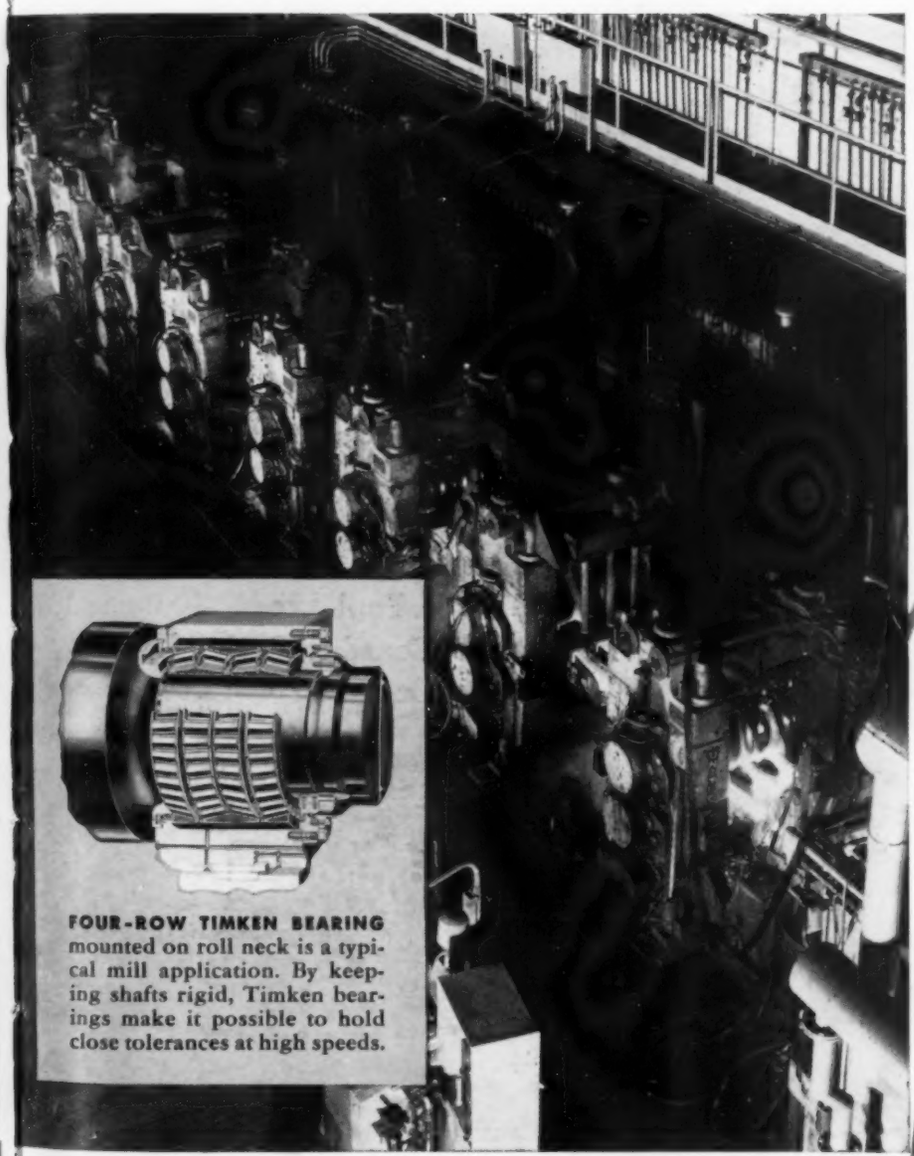
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

NOVEMBER, 1955

TECHNOLOGY DEPT.

TABLE OF CONTENTS, PAGE 55

How 32 TIMKEN® bearings help high-speed rod mill set tonnage record, maintain accurate gage



FOUR-ROW TIMKEN BEARING mounted on roll neck is a typical mill application. By keeping shafts rigid, Timken bearings make it possible to hold close tolerances at high speeds.

THIS 11″ rod mill at Jones & Laughlin's Aliquippa Works takes 2½″ square billets 30 feet long and turns them into rods .218″ in diameter at a rate up to 6,400 feet per minute. Output runs to a record 49.1 tons per turn.

To maintain minimum cost per ton of steel rolled, United Engineering equipped the 8 roughing stands with 32 Timken® tapered roller bearings on the roll necks, plus Timken bearings on the drive and pinion stands.

Timken bearings on this high-speed mill maintain alignment, because they can take both radial and thrust loads in any combination. Extra thrust devices aren't needed. And full line contact between rollers and races gives Timken bearings extra load-carrying capacity. Roll necks are held rigid; gage is maintained.

What's more with Timken bearings, mills can accelerate more rapidly because of lower starting resistance. At low speeds, mills can be adjusted quickly under full load without danger of scuffing the roll necks.

Timken bearings use economical grease lubrication—there's no need for large oil supply wells. Closures are more effective—Timken bearings keep housings and shafts concentric. The result is savings in time, maintenance costs and lubricant!

Improvements in roll neck bearing design and performance result from the Timken Company's experience and research in such fields as metallurgy and heat-treating. The Timken Company has also pioneered in testing roll neck bearing capacity requirements.

If you have an application for a roll neck bearing, the Timken Company engineers will be glad to help you. They have solved countless bearing problems throughout the steel industry. Write to: The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

AISI LIBRARY
NOV 1955
DETROIT

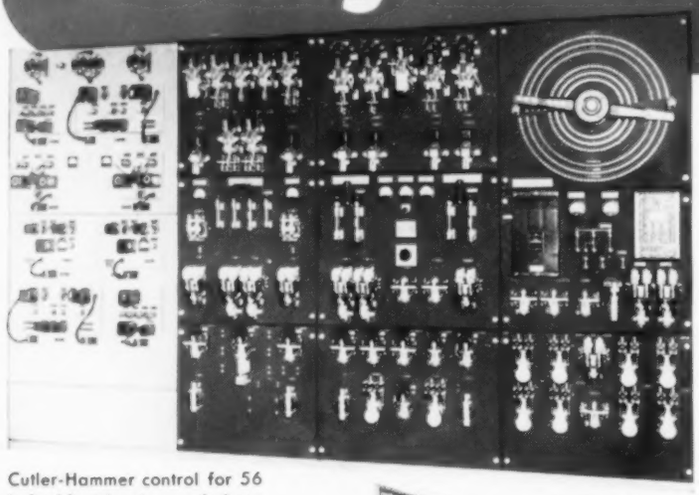
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

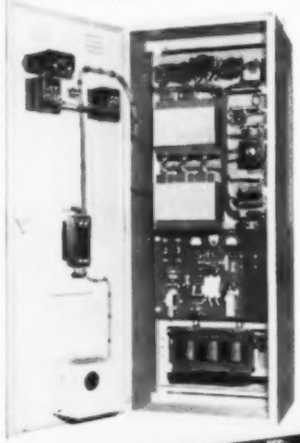
NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST ↔ LOADS OR ANY COMBINATION ↗

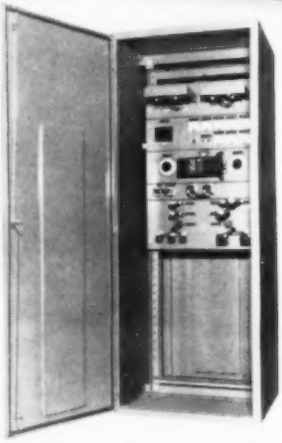
Nothing succeeds like success!



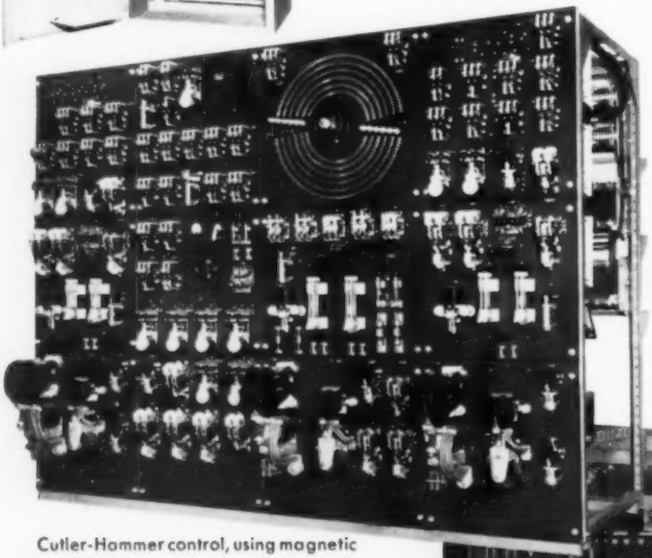
Cutler-Hammer control for 56 inch side trimming and shear line using magnetic amplifier.

Cutler-Hammer high frequency control for electric welding tube mill, using magnetic amplifier.

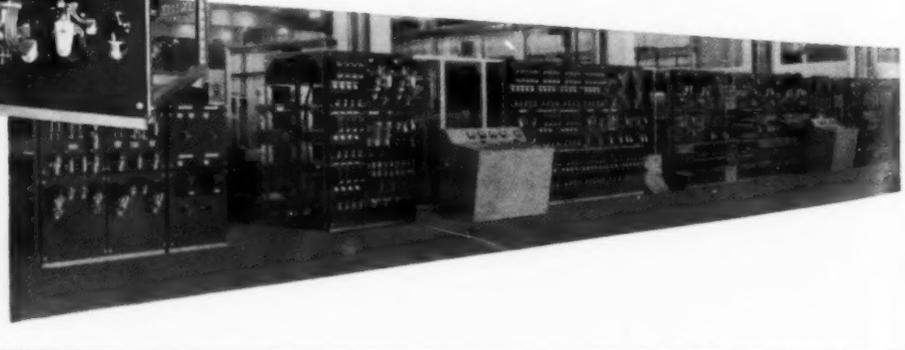




Cutler-Hammer magnetic amplifier speed regulator for a large tube mill.



Cutler-Hammer control, using magnetic amplifier, for reversing cold strip mill with tension and voltage regulation.



Cutler-Hammer D-C Controllers using magnetic amplifier for pipe mill in a southwestern steel mill.

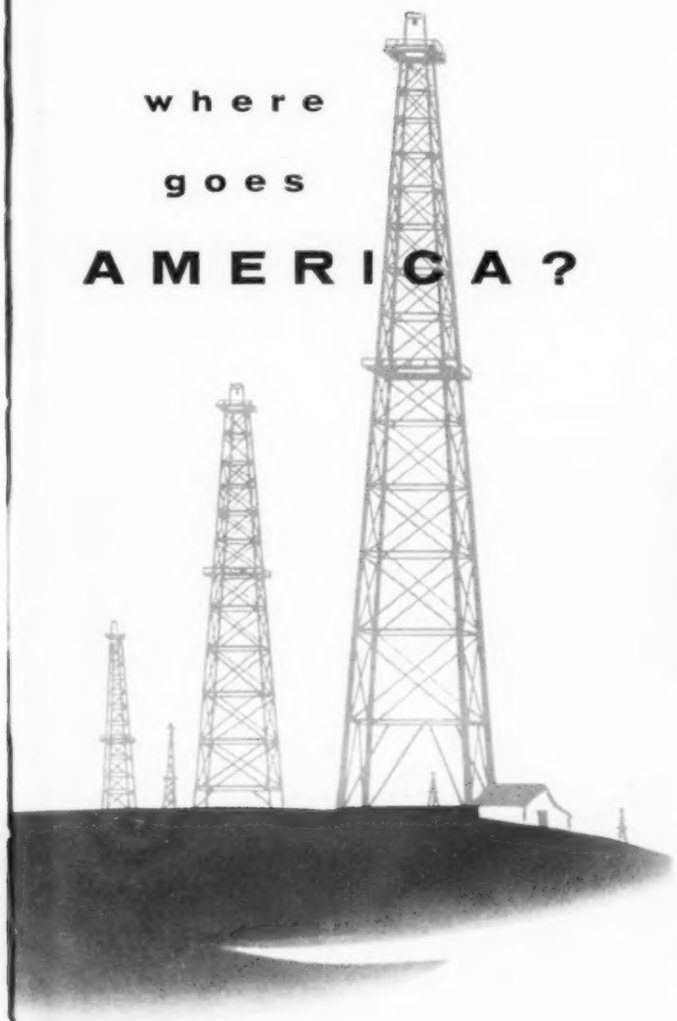
Cutler-Hammer's experience in applying the Magnetic Amplifier to steel mill control assures correct solution of your problems.

Cutler-Hammer has been so successful in the past in applying the magnetic amplifier to steel mill control schemes, it is very natural that companies looking for best results should come to Cutler-Hammer.

This further adds to Cutler-Hammer's backlog of experience, and gives more positive assurance that the control scheme will properly apply and utilize all the inherent advantages of this dependable control component that has no moving parts, is capable of split-second response and many amazing features. . . . Nothing succeeds like success! CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.



★ America goes after more and more oil and gas as demands increase . . . up about 5% in 1955. More wells will be drilled, an estimated 54,500. The average depth goes deeper, now down better than 4,000 feet. More and more pipe lines must be built . . . some 14,704 miles planned, approved or authorized. Every year more and more steel is required for production, processing and pipeline transportation per barrel of cubic foot of oil and gas.

All of this activity means more and more oil country goods and much of it will be seamless pipe and tubing.

Are your pipe and tube mills modernized or are you losing out competitively on quality or production?

Most of the ideas about making seamless tubing have been worked out between the steel industry and Aetna-Standard in 54 years association. Many new ideas are available from Aetna-Standard to make your pipe mills more productive. Or, if you are considering new facilities, Aetna has the facts on which to base an intelligent decision.

SUBSIDIARY and ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.
Standard Engineering Company, Ellwood City, Pa.
Trans-World Traders, Pittsburgh, Pa.

Designers and Builders to the Ferrous, Non-Ferrous, Leather, Rubber, and Plastic Industries

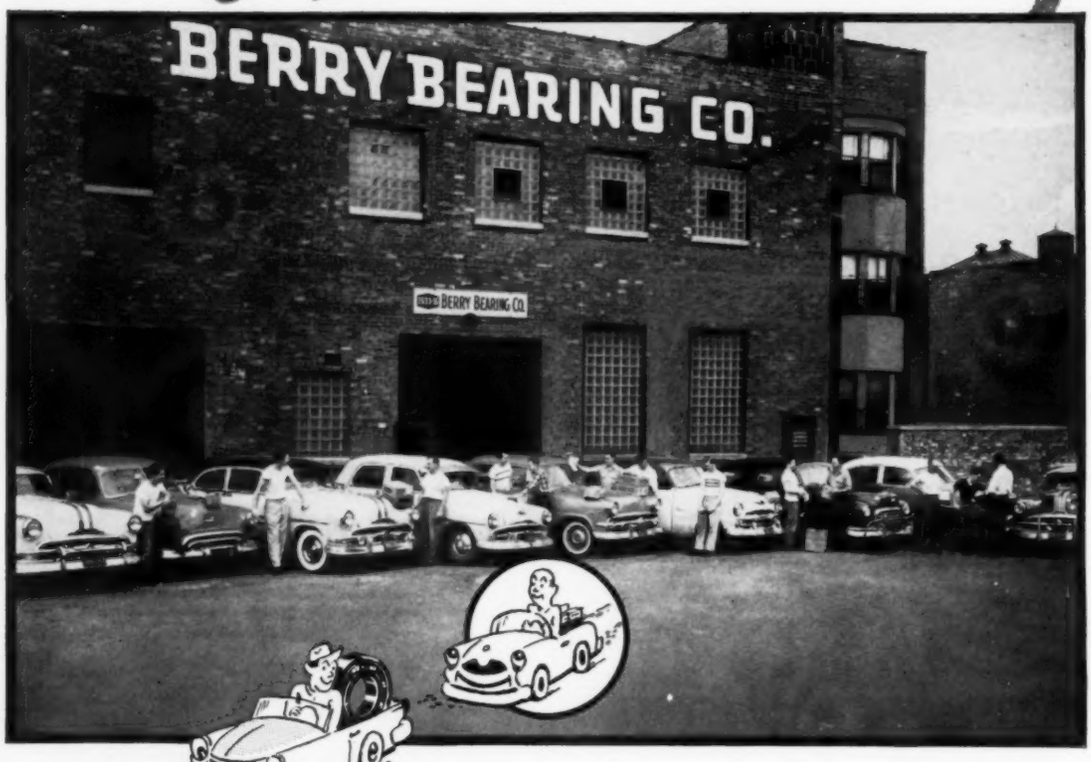
THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

Bearings Via BOULEVARD DELIVERY * give you Super Service Plus



* *BOULEVARD DELIVERY* is a Berry Bearing Company innovation designed to transport bearings to your plant--in the minimum amount of time. A whole fleet of passenger cars is used. They by-pass congested traffic lanes...and...travel over thru-streets and boulevards. Thus, you get your bearings--in the shortest possible time. And, with one of the largest and most diversified stocks, Berry can immediately supply practically ANY type, size, or brand of bearings you need. They'll come via Boulevard Delivery. So, you'll get Super Service Plus--on every order.

BERRY BEARING COMPANY

MEMBER AFBDA ANTI-FRICTION BEARING DISTRIBUTORS ASSOCIATION

All phones--DA nube 6-6800

2633 S. Michigan Ave. • • • • Chicago 16, Illinois

OAK PARK
327 Madison St.
EUclid 6-1700

ROCKFORD
1121 Fifth Ave.
Phone: 2-5561

HAMMOND
4828 Calumet Ave.
WEstmore 1-3010

GARY
716 E. 5th Ave.
TUrner 5-7501

This accident could have been prevented by using Alliance SAFETY HOOK BLOCK

Cables break and hook blocks fall when the block is run against the lifting beam of a crane at high speed. THIS DOES NOT OCCUR WITH ALLIANCE SAFETY TORQUE HOOK BLOCKS. Design features prevent it.

Each Alliance hook block is fitted with springs of sufficient capacity to cushion the impact of the block on the upper lifting beam. Before the springs come into action a plunger trips the circuit breaker, thereby disconnecting the motor. The springs then bring the hoist mechanism to a stop even before the hoist brakes are set. The Alliance Safety Hook Block can be installed on most existing cranes. Write for full information. You or your engineers can see an actual demonstration of this Alliance Safety Hook Block in our plant at any time . . . a short movie is also available. Let us help you eliminate tragic shop accidents. This is one of Alliance's contributions to safety in industry.

World's Largest Builders of World's Largest Cranes

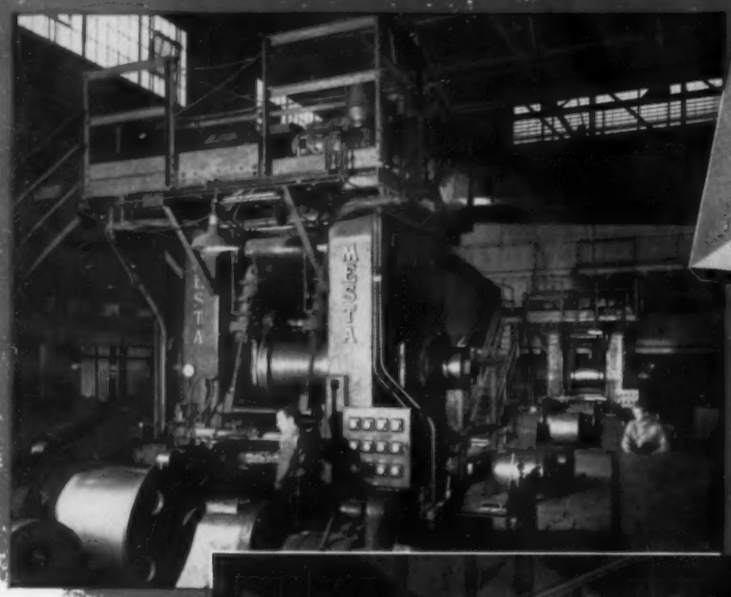
Give Us the Runway and We'll Lift the World

THE *Alliance* MACHINE COMPANY

Alliance, Ohio

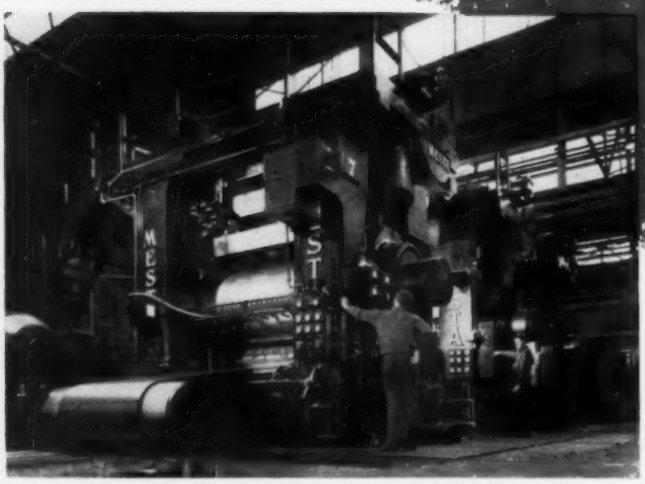
LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

Designed and Built by MESTA



42" Four-High Skin Pass
Mills for Tin Plate

96" Four-High Continuous
Hot Strip Mill Finishing Stands

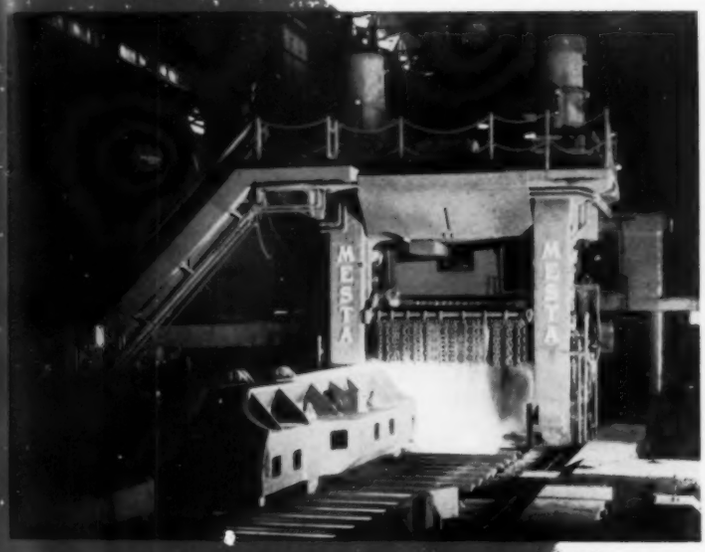


93" Four-High Three-Stand
Tandem Cold Mill

32" Mesta Patented
Pickling Machine

for JONES & LAUGHLIN STEEL CORPORATION

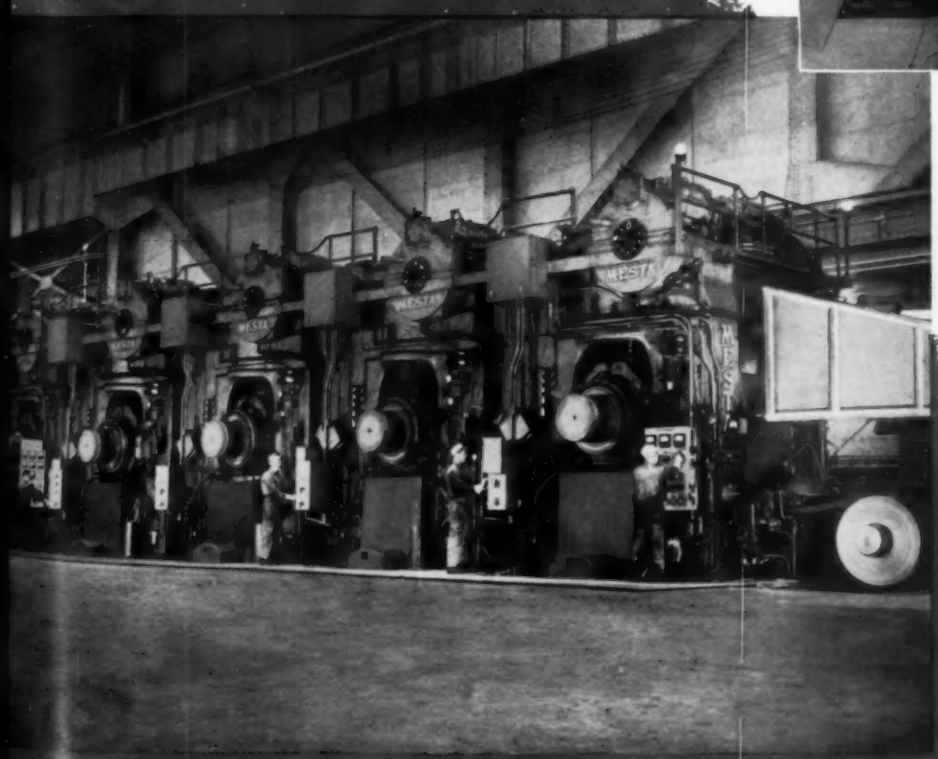
Pittsburgh, Pa.

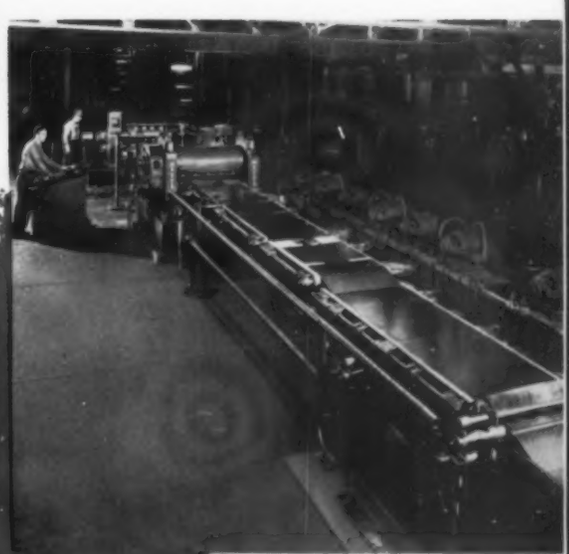


46" Reversing Slabbing-Blooming Mill

93" Continuous Pickling Lines for wide strip

42" Four-High Five-Stand High-Speed Tandem Cold Mill





[illegible] in Shearing Line with Trimmer and Combination Flying Shear and Leveller

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

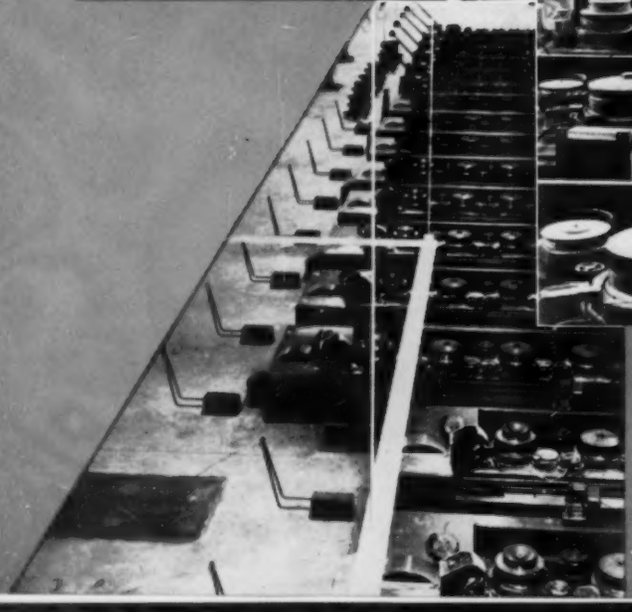
Wire BY THE CARLOAD OR THE TRAINLOAD

produced dependably at high rates by ...

Vaughn®

MOTOBLOX

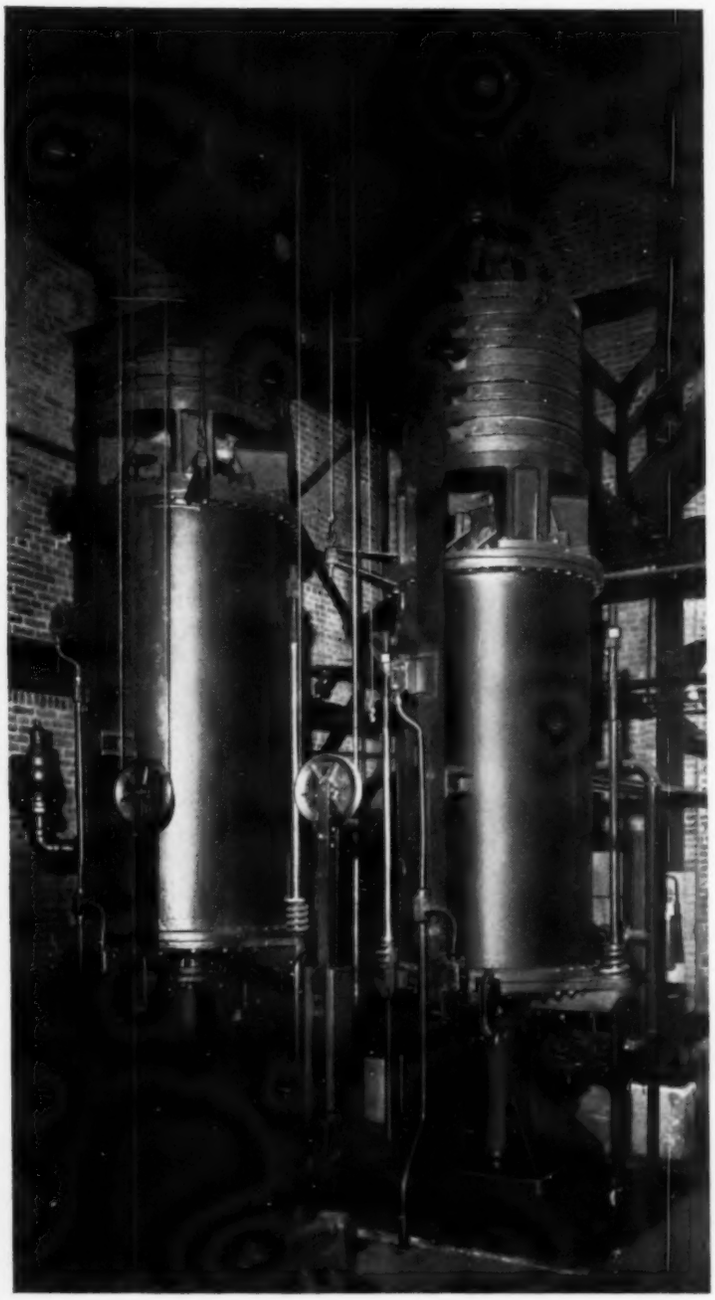
Let your high-volume needs in wire be matched by Vaughn Motoblox' high productivity! These famous machines meet quotas with quality—in speed and dependability. A Vaughn engineer will be happy to give you the facts, at your convenience.



The VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U.S.A.

COMPLETE COLD DRAWING EQUIPMENT—Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

7 Reasons For Proved Leadership of the Freyn-Design PNEUMATIC BELL HOIST



1 The Freyn-Design Pneumatic Bell Hoist uses the least expensive, most dependable operating power around the blast furnace—cold blast air. On a furnace wind check, or even in the event of low wind pressure, the plant compressed air system automatically provides sufficient operating power.

2 Bells are cushioned during operation by the pneumatic action of the air cylinders.

3 Damage is prevented to the bell hoist, bell levers and bells in the event of an explosion between the bells by the automatic opening and closing of the large bell, which relieves the gas pressure created by the explosion.

4 Independent adjustment is provided to control the bell speed of travel in either direction —can be set for fast opening and slow closing if desired.

5 There are no counterweights on the bell levers at the top of the furnace. Only a limited amount of counterweight is needed on the bell cylinders because they're double acting—use air pressure to help hold bells closed.

6 No limit switches are needed to stop the bell actuating mechanism at ends of bell travel.

7 The mechanical simplicity of design provides long life with little maintenance.

More than 70 installations—many on repeat purchases—prove the dependability, and the economy, of the Freyn-Design Pneumatic Bell Hoist. Send for descriptive folder that gives you all the facts. Consult our engineers.

CONSULT OUR ENGINEERS

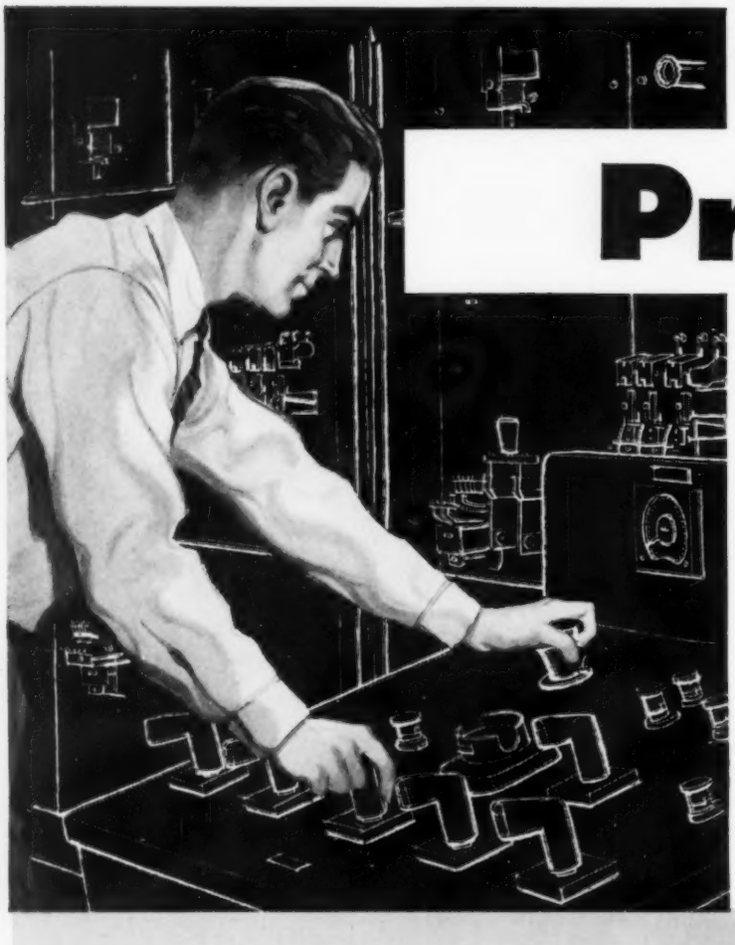
KOPPERS

KOPPERS COMPANY, INC.

Freyn Department

Engineering & Construction Division

KOPPERS BUILDING • PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Lattre & Frouard, Paris, FRANCE



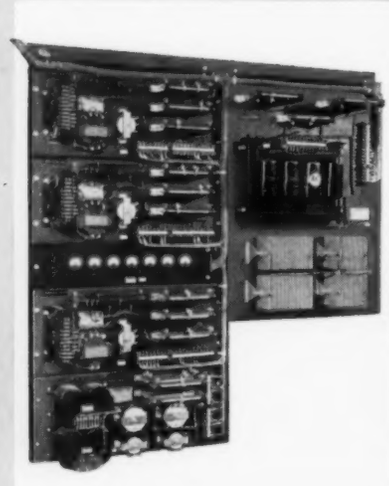
ALLIS-Processing

Allis-Chalmers constant potential and variable voltage systems are providing dependable precision control in many of the nation's largest mills.

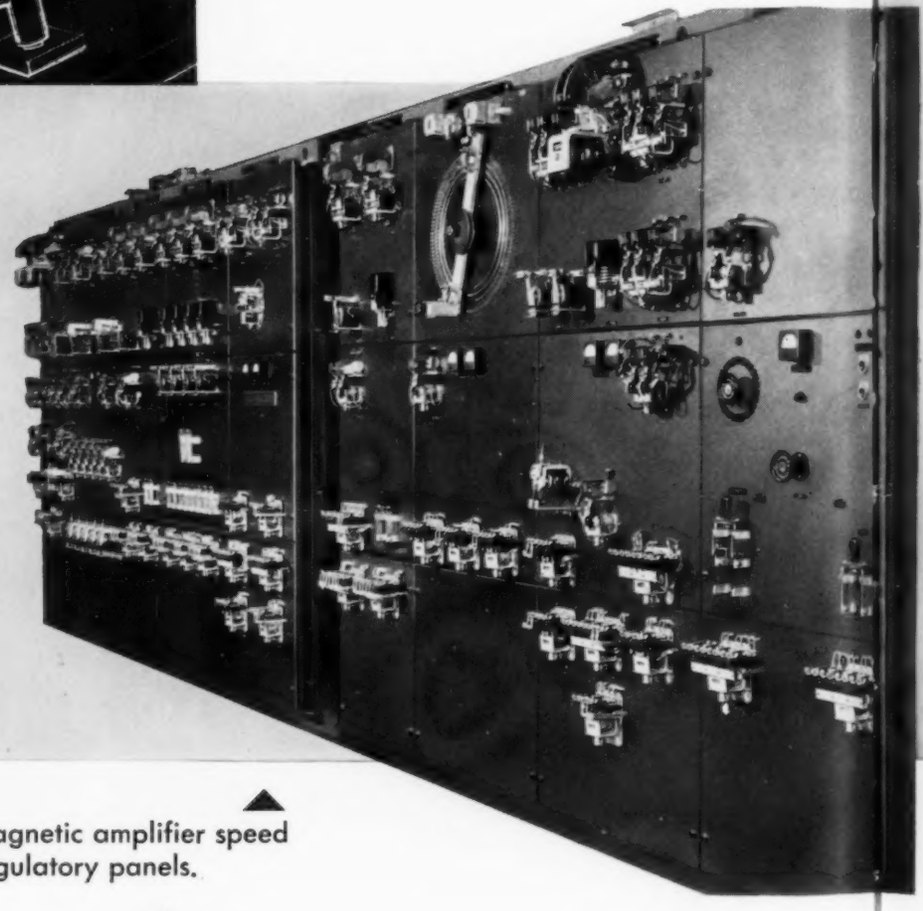
When you modernize

to meet the double challenge of a growing market and heavy competition, take advantage of Allis-Chalmers experience. See your nearby representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4659



▲ Variable voltage control board for 39-inch continuous annealing line.



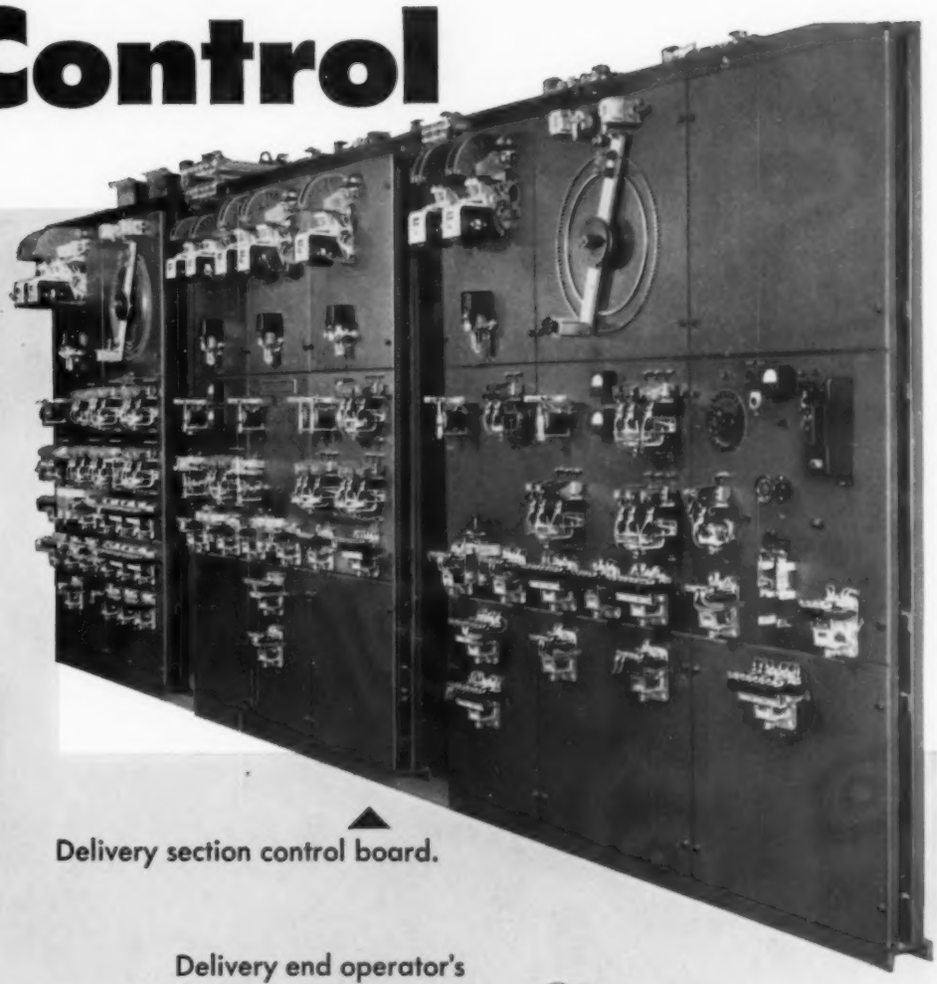
▲ Magnetic amplifier speed regulatory panels.

A-C ALLIS-CHALMERS

ALLIS-

CHALMERS
Line Control

Entry section control board for pickle line.



Delivery section control board.

Delivery end operator's desk, stainless steel top.

Riveter's cabinet, stainless steel front.

CHALMERS

Pollock Experience at No Extra Cost

The William B. Pollock Company has been serving the iron and steel industry the world over since 1863.

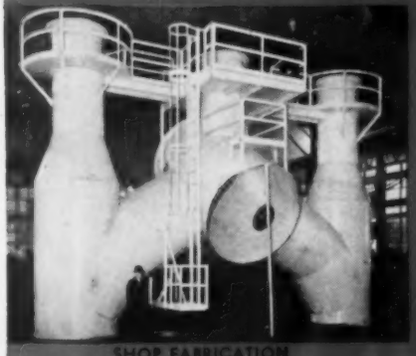
Pioneers in heavy steel work, Pollock is excellently qualified, equipped and staffed to design and build your special heavy-duty equipment.

Pollock is known for its reliable, efficient precision work. You, too, can benefit from Pollock's broad experience.

BLAST FURNACE CINDER CAR AND OPEN HEARTH SLAG CAR

HEAT RETAINING DE-MOUNTABLE HOT METAL LADLE CAR

PICTURED ABOVE IS POLLOCK FIELD ERECTION EQUIPMENT IN THE PROCESS OF ERECTING A MODERN BLAST FURNACE



SHOP FABRICATION

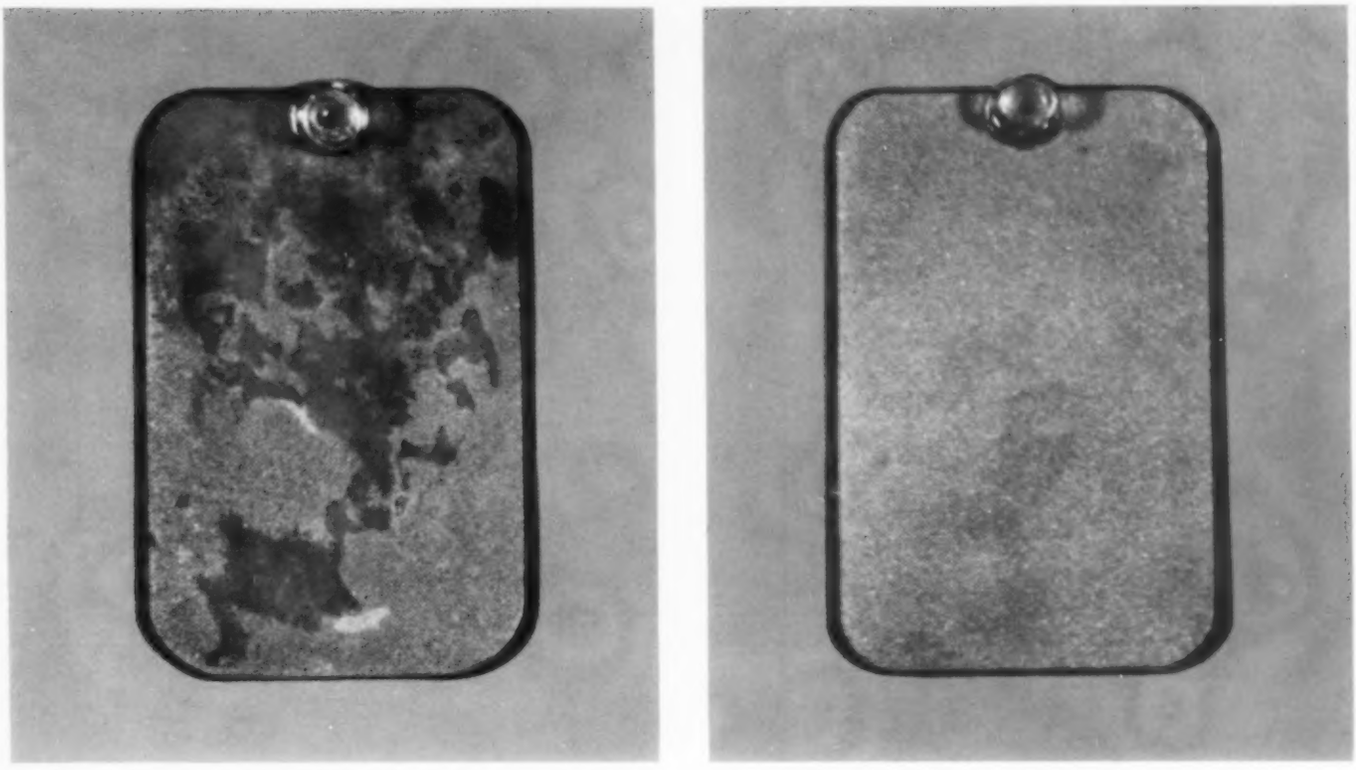
WELDED OPEN HEARTH LADLE

FIELD ERECTION

POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

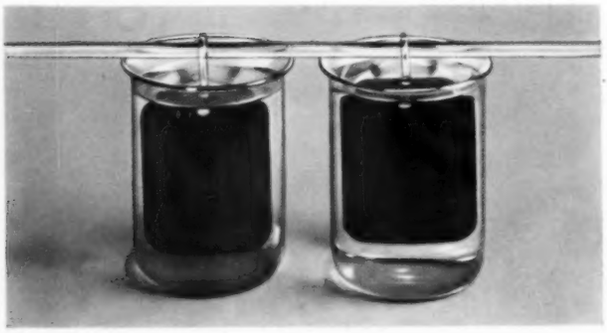
BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOLD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES



Efficiency of New Sun Rust-Preventive Grease is shown by accelerated test. Rusted test plate (left) was coated with ordinary grease. The large amount of rust was formed during a 48 hour immersion in synthetic sea water. Plate (right) protected by new Sun rust-preventive grease is wholly rust free after 48 hours.

NEW GREASES PREVENT HARMFUL RUST

Sun rust-preventive greases give improved lubrication ...protect against wet or humid operating conditions



In 48 Hour Synthetic Sea Water Test, rust from plate coated with ordinary grease has turned water yellow (left). Water remains crystal clear in beaker with plate protected by new Sun rust-preventive grease (right).

Water contamination in grease-lubricated parts reduces lubricant life, promotes corrosive wear, and may lead to failure of bearing surfaces.

Sun Oil's new rust-preventive greases are specially fortified to overcome this problem. They give extra protection against both direct water contamination and indirect water contamination caused by high humidity and condensation during overnight and week-end shut downs.

Available at the price of ordinary greases, new Sun rust-preventive greases come in many different grades. For complete information, see your Sun representative, or write for Sun Technical Bulletin 38. Address SUN OIL COMPANY, Philadelphia 3, Pa., Dept. GI-1.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

PHILADELPHIA 3, PA.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO & MONTREAL

SUNOCO®

PLEASE TURN TO NEXT PAGE

New buttery grease now protects against rust under highly adverse moisture conditions.

New tacky grease prevents throw-off... reduces consumption. Highly resistant to water.

New high-temperature grease for anti-friction bearings. Exceptional stability, longer life.

NEW SUN RUST-PREVENTIVE GREASES SAVE YOU MONEY IN 3 WAYS

- **Prevent wear... and rust... on 90% of all grease jobs**
- •• **Serve as low-cost rust preventives for storing shop equipment**
- ••• **Save storing and handling special-purpose greases**

Sun Oil Company's new greases are fortified to protect against rust. Lubricity is improved and wear is reduced because grease-lubricated parts are now protected at all times against rust and corrosion caused by condensation and process water.

The effective life of these new rust-preventive greases is approximately twice that of conventional greases operating under wet conditions. And, their extra protection against moisture permits their use as a rust-proofing medium for shop storage of tools and parts.

Competitively priced with ordinary greases, these new greases can be applied by any conventional method... brush, swab, pressure gun, or through central pressure systems.

Because of their improved quality, these new Sun greases will now perform 90% of all grease lubrication jobs. You reduce grease inventories ...lessen the risk of using the wrong grease... simplify your handling problems.

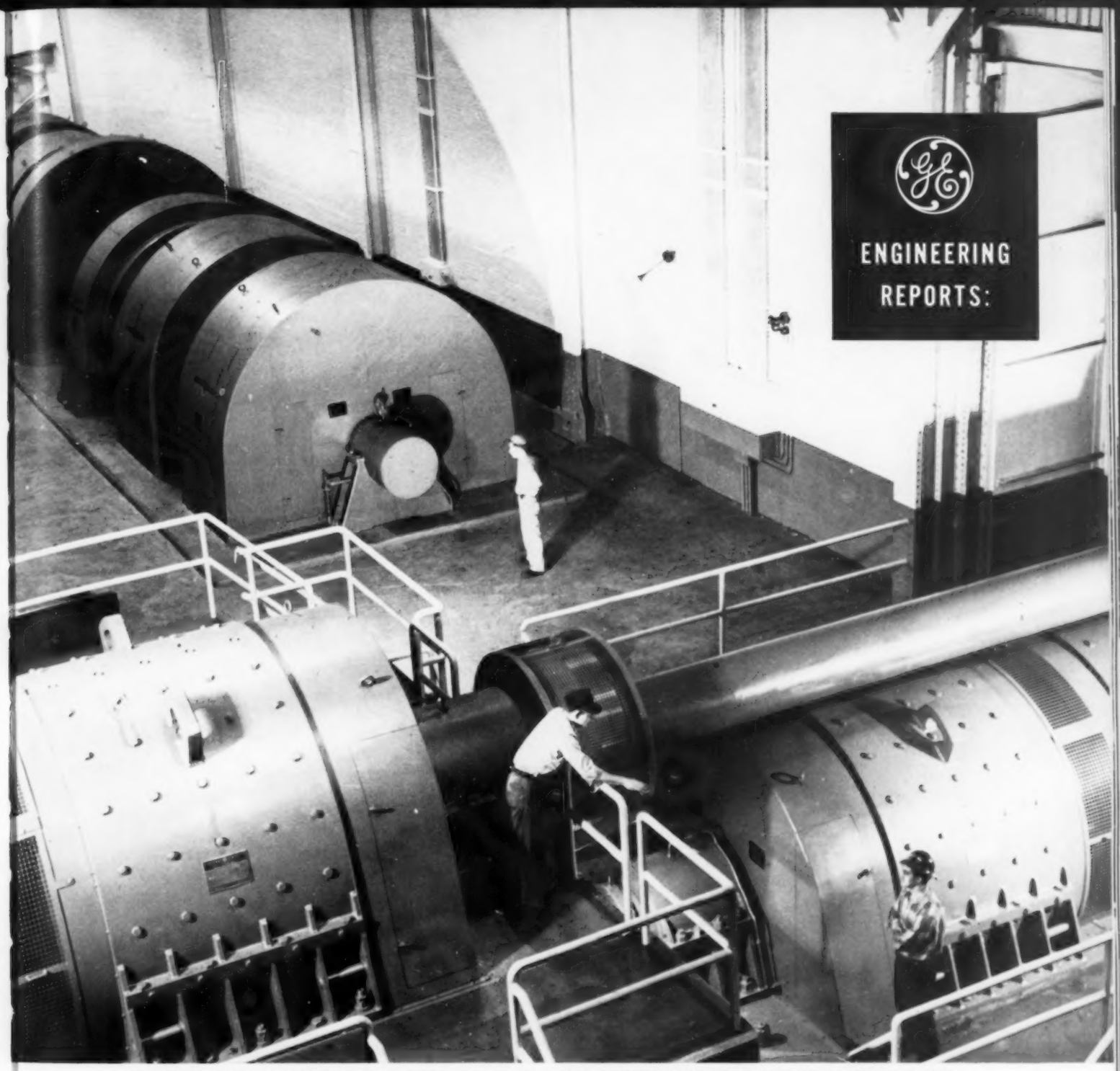
For complete information, see your Sun representative or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. GI-2.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY, PHILADELPHIA 3, PA.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL



AT JONES AND LAUGHLIN'S ALIQUIPPA, PA. MILL, FOUR GENERAL ELECTRIC 3000-HP MOTORS DRIVE . . .

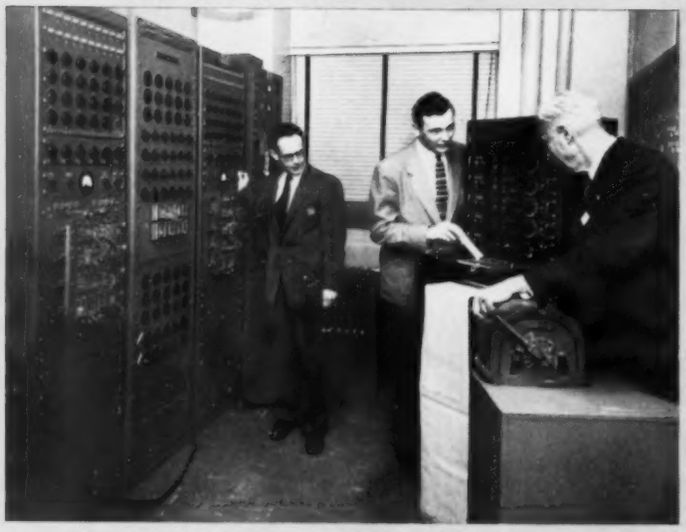
Record-breaking reversing blooming mill

Jones and Laughlin's 44 in. blooming mill at Aliquippa, Pa., has smashed all previous world production records for small ingots. Powered by a coordinated General Electric drive system, this mill which is reversed from 70 rpm to 70 rmp in one second, has rolled 576 ingots in one eight hour shift—a 10 per cent increase over the old record set by the same mill when it was steam-driven.

J&L's conversion from steam to electric drive was an outstanding feat. In only 7 days, 14¼ hours the mill was back in full, around-the-clock production. This was more than two days ahead of the schedule set up for the changeover. For the story of the conversion and how G-E engineering services aided J&L in this operation see the following pages.

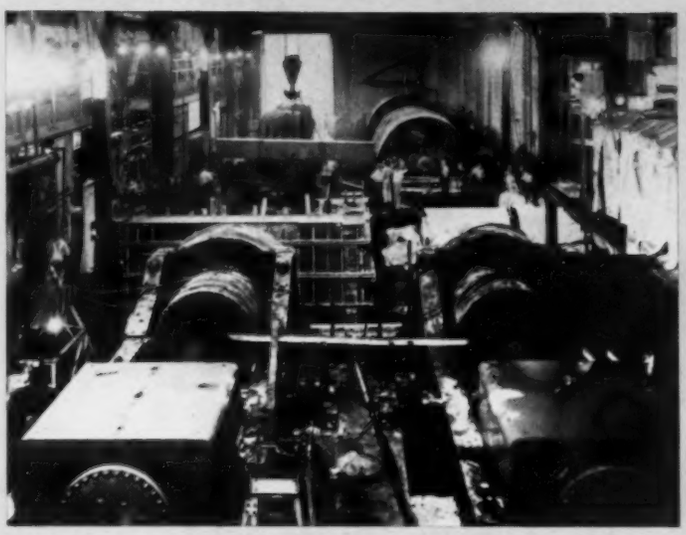
SEE CONVERSION STORY ▶

GENERAL ELECTRIC



GENERAL ELECTRIC engineers pre-determined electric drive system adjustments with electronic differential analyzer, and built wooden scale model of drive to rehearse conversion.

GENERAL ELECTRIC



JONES & LAUGHLIN engineers directed entire conversion, working day and night. Approximately 200 workmen per turn were utilized in the change-over which saw . . .

FULL PRODUCTION RESTORED IN 7 DAYS, 14½ HOURS

To help assure that Jones and Laughlin's conversion from steam to electric drive would be completed within 10 days, and that the new drive would help J&L surpass old production records, General Electric utilized its full range of engineering services.

Working closely with J&L, G-E analytical engineers simulated all operating conditions on an electronic differential analyzer. With G-E product engineers assisting, the design and adjustment of the electrical system were determined after "runs" of the mill on the analyzer were examined. As a result of these computer studies, the drive system was "tailored" to meet the exact requirements of Jones & Laughlin.

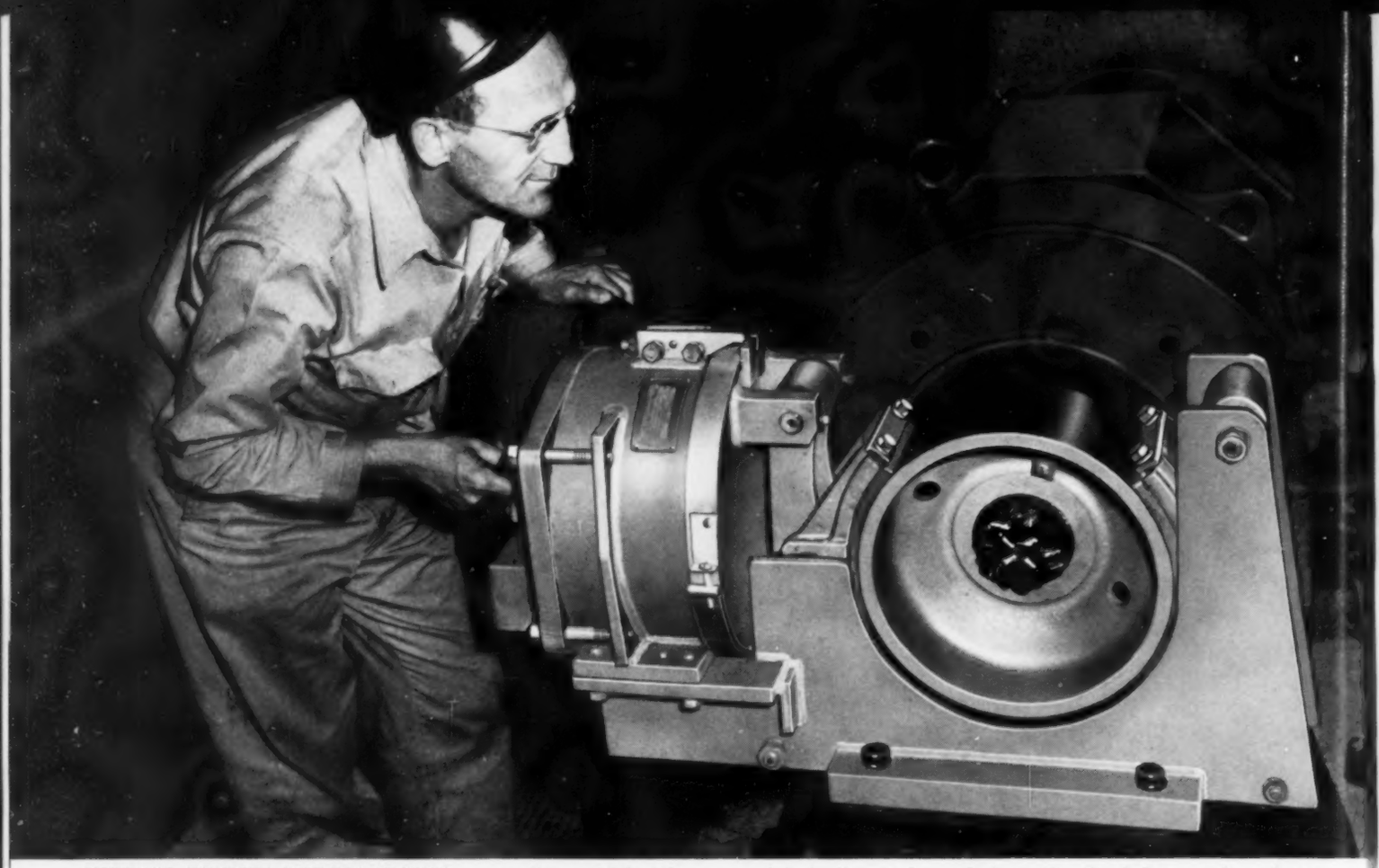
To help speed the conversion, a wooden scale model of the 12,000-hp main drive, its foundation and the steam engine foundation was built to study the problems involved in the installation. The model was assembled and disassembled piece by piece as J&L and G-E engineers rehearsed the actual changeover.

More time was saved when the electrical system was designed so that switchgear, m-g sets, exciter sets, control and even ventilating equipment could be installed and tested before the old drive was shut down. G-E field engineers were on hand to assist in the conversion and start-up of the drive.

These G-E engineering services are available to you. They will help save you time and money whether you are planning to modernize, expand, or build. For further information about these engineering services, contact your nearest G-E Apparatus Sales Representative, or send for bulletin GEA-2244. General Electric Company, Schenectady 5, N. Y. 659-106

Engineered Electric Systems for Steel Mills

GENERAL ELECTRIC



DESIGNED TO MEET AISE STANDARDS, a new General Electric single-magnet, two-shoe, direct-current brake is shown installed on a slab depiler at Jones & Laughlin Steel Corporation plant — Cleveland Division. All brake settings are made at one end.

New General Electric d-c brake with single-point adjustment cuts maintenance time at J&L

ONE OF THE FIRST General Electric direct-current brakes with single-point adjustment underwent tests at Jones & Laughlin Steel Corporation's Cleveland Division. On actual rigid application duty J&L found the brake needed a minimum of maintenance and reduced expensive down-time. New design features which won the approval of J&L maintenance personnel are as follows:

ONE EASY ADJUSTMENT with a wrench is all that is needed to correct for lining wear. Even where one lining wears more than the other, a self-centering fulcrum automatically equalizes both shoe clearances.

ARMATURE GAP INDICATOR shows when to make lining wear adjustment. Normal gap position is clearly shown on this readily accessible gage.

SET AND FORGET torque on the new G-E brake, no more adjustments are necessary. Should the brake's rating be changed, torque setting is easily varied to correspond.

BUILT TO AISE STANDARDS the new brake is suitable for both horizontal and vertical mounting under most conditions. It can be right- or left-hand mounted with no change in pins or bolts.

MORE VERSATILE INSTALLATION is possible with the new brake because all necessary adjustments, settings, and connections can be made from one end. This allows the equipment to be mounted within tight space limitations—only one end need be accessible.

REMOVABLE LININGS can be slipped out with a screw driver after holding bolts are removed—no need to disassemble complete brake shoe.

UNIQUE STRONGBOX MAGNET COIL is easily removable independent of complete magnet assembly. Coil construction seals out dust, moisture, oil, and helps protect windings against mechanical damage.

REDUCE MAINTENANCE and down-time as J&L did—get G.E.'s new d-c brake. For more information contact your nearest General Electric Co. Apparatus Sales Office or send for Bulletin GEA-6214. Section 781-10, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Here's how **RUST-OLEUM**®

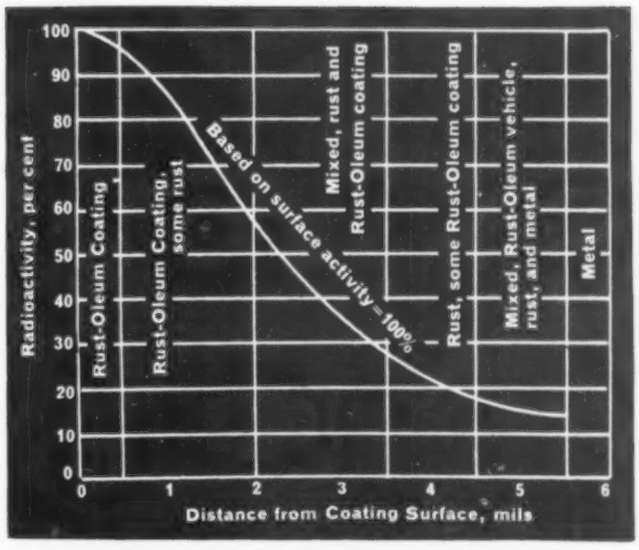
penetrates rust to bare metal on your rusted surfaces as seen through the "eyes" of radioactivity

Illustration of cross section of rusted metal coated with Rust-Oleum (enlarged 150 times)

Geiger Counter Traces Rust-Oleum Penetration Through Rust to Bare Metal

When you apply Rust-Oleum 769 Damp-Proof Red Primer directly over rust, the specially-processed Rust-Oleum fish oil vehicle works around the rust particles, through the fissures in the rust formation, and into the pits in bare metal—driving out air and moisture. *Irrefutable proof* of this penetration is now yours . . . the results of nearly three years' research utilizing radioactive tracing with C^{14} radioisotope.

The methods and results of this research are presented in a complete thirty-page report, entitled "The Development of a Method to Determine the Degree of Penetration of a Rust-Oleum Fish-Oil-Based Protective Coating into Rust on Steel Specimens," prepared by Battelle Memorial Institute technologists. Clip the coupon to your letterhead for your copy. There is no cost or obligation.



RUST-OLEUM®

STOPS RUST!

Rust-Oleum is distinctive as your own fingerprint. Accept no substitutes. Be sure you get only genuine Rust-Oleum.

ATTACH TO YOUR BUSINESS LETTERHEAD
FOR YOUR COPY OF THIS THIRTY-PAGE REPORT

Rust-Oleum Corporation
2444 Oakton Street, Evanston, Illinois

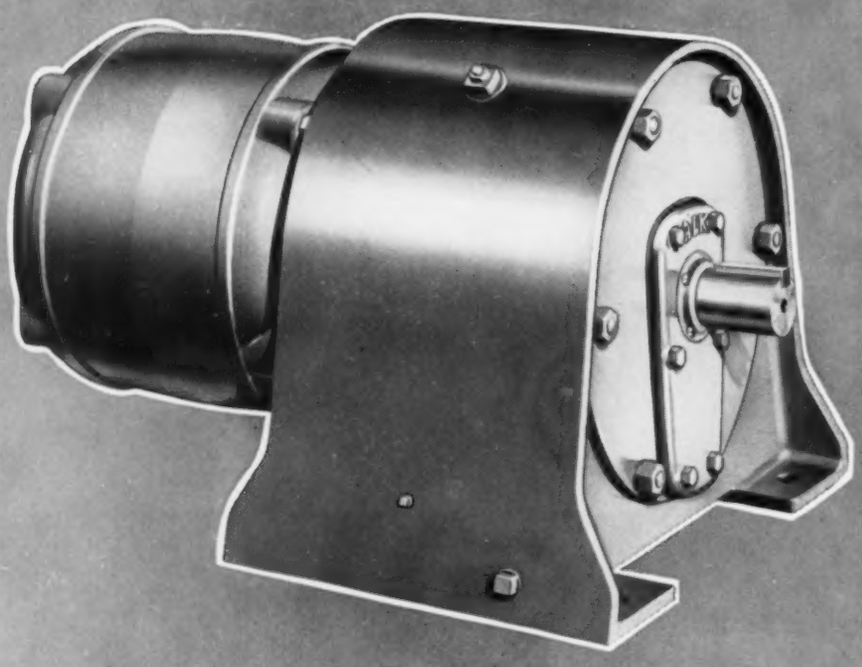
- ☐ Please send me without cost or obligation the complete thirty-page report on Rust-Oleum penetration.
- ☐ Complete literature and color charts showing Rust-Oleum colors.
- ☐ Nearest source of supply.

Announcing the *–Newly Designed–* Integral

ALL-STEEL FALK Motoreducer

(Gearmotor Type–Supplementing Falk All-Motor Line)

. . . with completely standard round-frame, D-flange motor



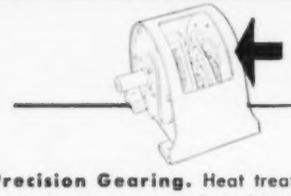
Check and Compare these features...

Meet a faithful old friend in a new, modern dress! The famous, time-proved Integral Type *all-steel* Falk Motoreducer (Supplementing Falk All-Motor Line) has been redesigned into a compact, streamlined unit providing the utmost in space economy—but retaining all the application versatility, long-life performance, easy-maintenance features and superior structural qualities that have made Falk Motoreducers the recognized standard throughout industry.

In this new Integral unit—rated in accordance with AGMA standards—a *completely standard* round-frame, D flange NEMA motor is mounted directly on the all-steel Motoreducer housing. The motor remains a separate piece of equipment, readily replaceable with any other type or make. Output speed (ratio) can be changed within unit's torque capacity without modifying motor. Size and arrangement of the standard housing permit wide ratio range—from 3.36:1 to 542:1.

In order to meet the greatest number of industrial application needs, the newly designed Integral Motoreducers are available in horizontal and vertical models, both in concentric and right-angle types; double, triple and quadruple reduction; horsepower range, 1 to 40 HP. Prompt stock shipment in standard ratios is offered.

Whatever your reduction requirements, you get greatest dollar-for-dollar value in the long run by standardizing on Falk products. Write for Bulletin 3104.



Every FALK Motoreducer has these "In-built" Factors—

Precision Gearing. Heat treated alloy steel, precision cut and shaved helical gearing throughout . . . quiet-operating crown shaved pinions . . . taper bored gears for easy ratio changes.

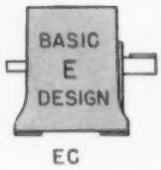
All-steel Housings. Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

Streamlined inside and outside. Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

Positive Lubrication. Large sump capacity . . . oil-tight construction assures clean lubricant . . . direct dip of revolving elements provides positive lubrication at all speeds.

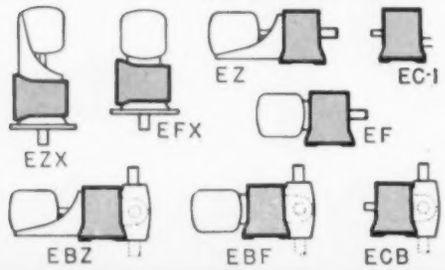
Wide Speed Range. Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

Sealed Housings. Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splash-proof, leakproof, dustproof.



EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



FALK ...a good name in industry

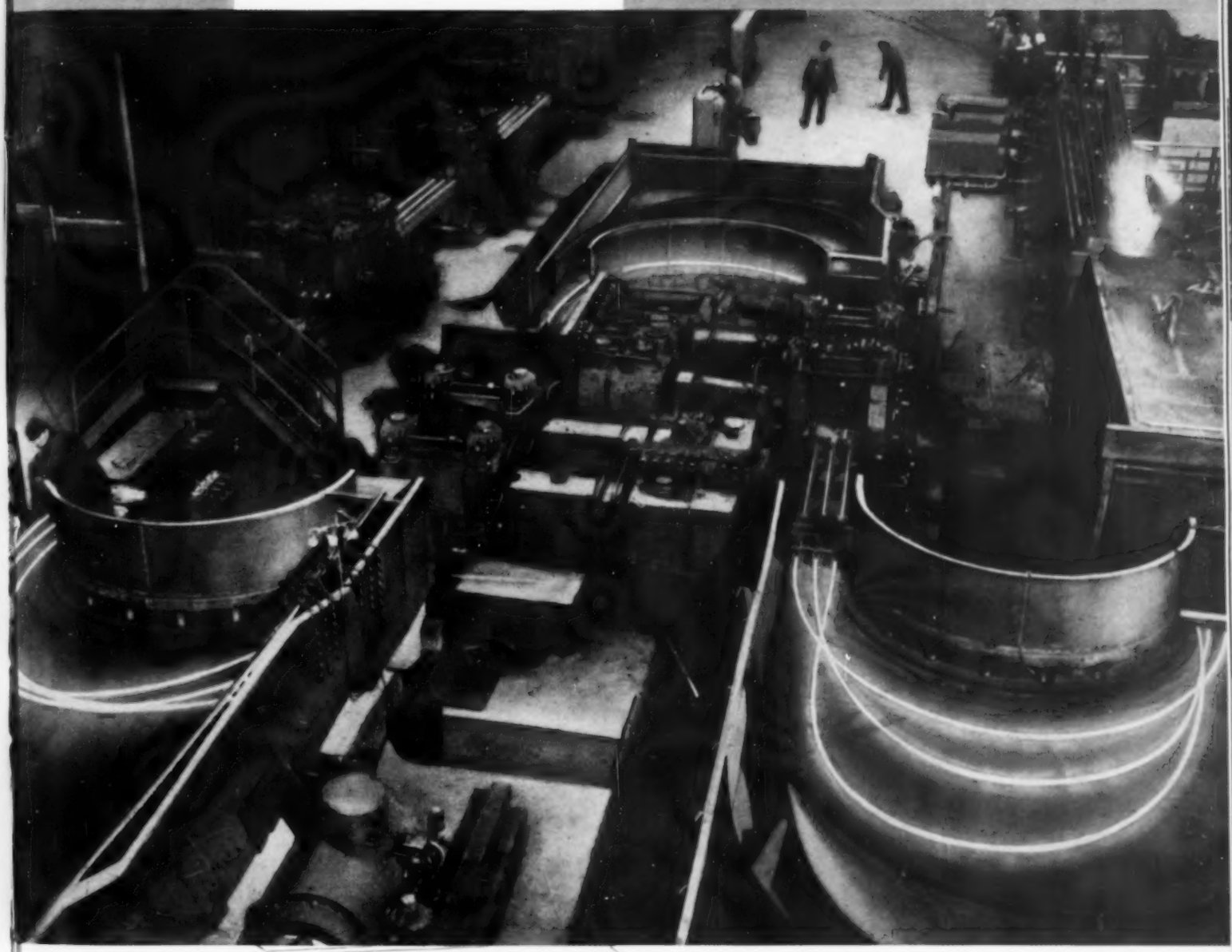
THE FALK CORPORATION · 3001 W. Canal St. · Milwaukee 8, Wis.

WRITE FOR BULLETIN 3104

UNITED®

RENDLEMAN ROD MILL

HIGHER PRODUCTION RATE THAN ATTAINED ON ANY OTHER ROD MILL *



Designed and Built by

UNITED®

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at: PITTSBURGH • VANDERGRIFT • YOUNGSTOWN
CANTON • WILMINGTON (LOBDELL UNITED DIVISION)

Subsidiaries: ADAMSON UNITED COMPANY, AKRON, OHIO
STEDMAN FOUNDRY AND MACHINE CO., INC., AURORA, INDIANA

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

*

- **CONDITIONING OF BILLETS UNNECESSARY.**
- **FEWER ROLL CHANGES REQUIRED.**
- **LOWER ROLL and GUIDE MAINTENANCE COST.**
- **BETTER QUALITY RODS AT LOWER COST.**

UNITED *can serve you no matter where in the world you are.*

Two 30 ton, 75 ft. span Bedford magnet cranes with 15 ton bucket auxiliaries working over the cinder yard—used as skull crackers in Detroit Steel Company's mill at New Boston (Portsmouth), Ohio.

Bedford Steel Mill Cranes are individually engineered for each specific application

In steel mills, power plants and throughout heavy industry, wherever superior performance is *expected,* experienced owners are enthusiastically recommending Bedford cranes.

Further proof of the superiority of Bedford cranes is found in the high percentage of *repeat orders* from important owners through the years.

Built to the most modern standards and backed by more than 52 years of specialized crane building *and utilization* experience . . .Bedford cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

Available in all types and sizes . . . from 5 tons to 350 tons, and up, for all kinds of indoor and outdoor services . . . each Bedford crane is individually engineered and precision built for its specific application.

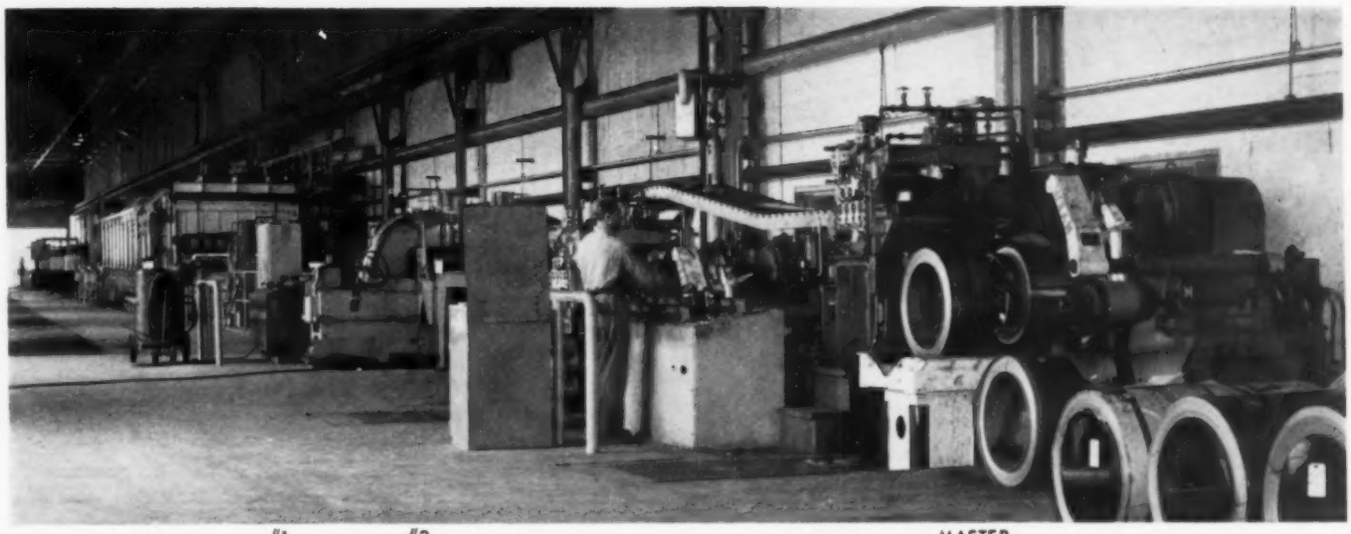
You are invited to consult a Bedford engineer on your next crane problem . . . with all the facts on the table we believe you too will make your next crane a Bedford.

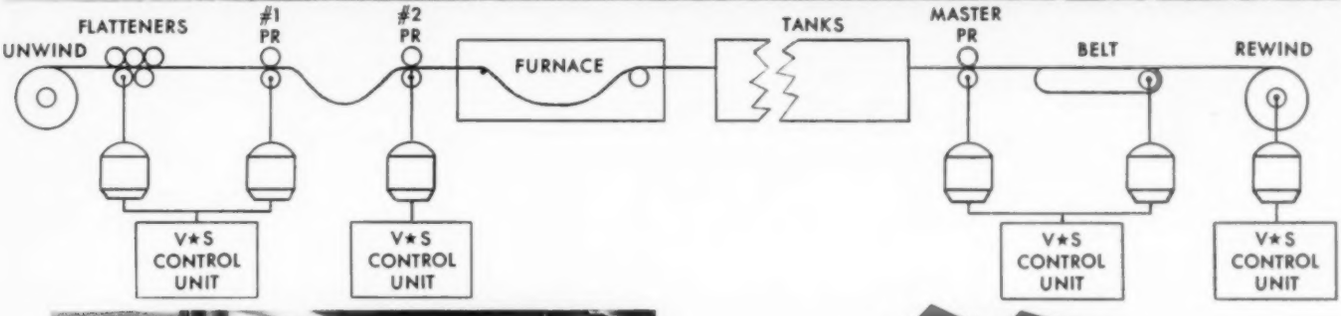
New York Office: 30 Church St., Room 426
New York 7, N. Y., Phone COrtlandt 7-1896

Pittsburgh Office: Oliver Building, Room 1141
Phone ATlantic 1-0136

BEDFORD CRANE SERVICE — STEEL MILL CRANES — BEDFORD

BEDFORD FOUNDRY & MACHINE COMPANY, INC. • BEDFORD, INDIANA





Pickling Line V★S Drive Control Units

RELIANCE V★S DRIVE®

PACKAGED DRIVES KEEP STAINLESS ON THE MOVE

As much as 14 miles of stainless steel strip is processed each day on the Atlas Steels, Ltd. two-strand pickling line . . . Canada's first continuous stainless steel pickling line.

Because this is a large stainless line requiring special care to prevent surface marring or scratching, consideration had to be given to the drive system. The drive requirements were for precisely controlled tension over wide speed ranges with extremely reliable control. Reliance V★S Drives with built-in electronic regulators keep the line moving and afford the flexibility to permit line speeds from 5 to 50 feet per minute for strip .007 to .187 inches thick and 10 to 20 inches wide.

Four compact V★S Control Units which house the factory-wired motor-generator sets and the control panels supply power to the motors for each half of the twin line. The "packaged" feature of the drive means extreme ease of installation and a great saving in installation cost plus the ability to tailor the drive system to the actual requirements. This "tailoring" meant that wide constant-horsepower speed range motors could be used to fit in with the line speed variables. These variables were created by the need for running strip of varying thicknesses and widths through the line at speeds dictated by the annealing furnace "constant tons per hour" limits.

This is a good example of the ability of Reliance to tailor drive systems to the specific application requirements of the steel industry. Write for Bulletin A-1555. D-1502-A

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities

Canadian Division: Welland, Ontario

Builders of the Tools of Automation

Catenary Furnaces

A 12,000 lbs/hour Fuel-fired Catenary Annealing Furnace for stainless strip used in line with spray quench followed by descaling and pickling baths.

FURNACE CHARACTERISTICS

Inside Dimensions 50'-0" long x 7'-0" wide x 6'-8⅜" high

Fuel Input ..... 1,800,000 BTU/hour

Operating Temperature Range . . 1200 to 2250°F

Stainless Strip . . . . . Cold reduced—annealed in gauges from 0.007" to 0.125"

Stainless Strip . . . . . Hot rolled—annealed in gauges from 0.093" to 0.200"

Three (3) zone proportioning control

Complete control over fuel-air ratio to maintain desired atmosphere in furnace

DREVER COMPANY

RED LION RD. & PHILMONT AVE., BETHAYRES, PA.

23

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period June 14, 1955 through July 12, 1955 . . . .

TREATMENT OF STEEL MILL WASTES

▲ U.S. 2,710,796, issued June 14, 1955 to Robert G. Pinkerton and assigned to United States Steel Corp., describes a process and apparatus for the treatment of blast-furnace flue dust, open-hearth slag, coke breeze, and roll scale, scarfing cinder, chips, turnings or burnings, or similar metal-containing waste incident to steel mill operations.

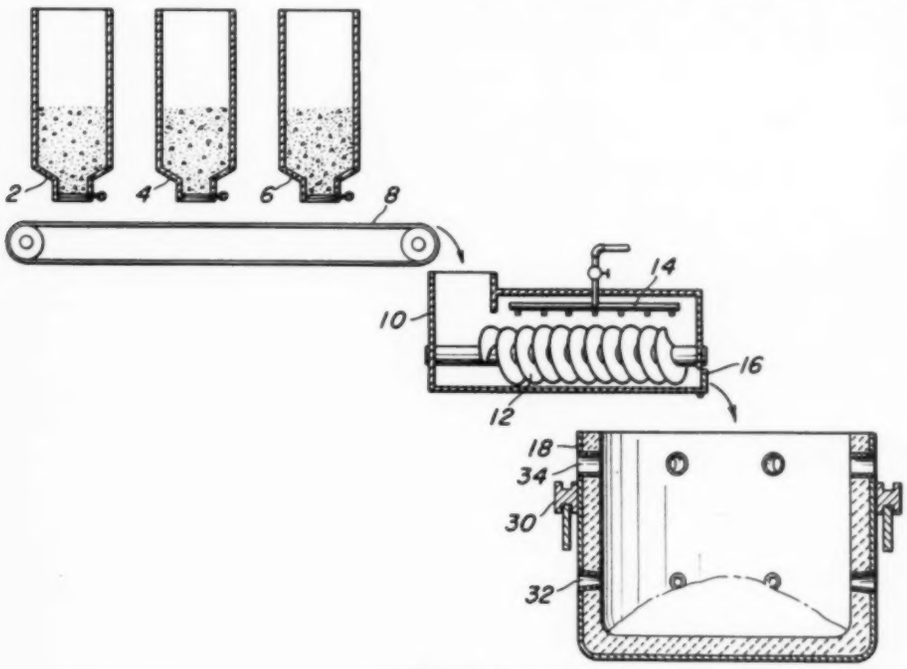


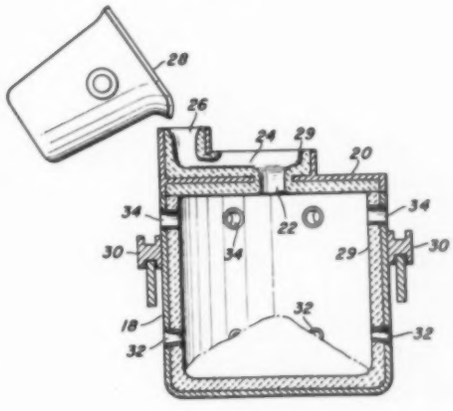
Figure 1

The method is shown in Figures 1 and 2. The hopper 2 contains a supply of open hearth slag, crushed and sized to pass a two-in. screen. Hopper 4 contains a supply of blast-furnace flue dust. Carbon in the form of coke-breeze may be added from hopper 6, if the carbon content of the flue dust is low. The coke-breeze can be mixed with metal wastes from the plant.

The hoppers are positioned in line over a belt conveyor 8 which moves measured quantities of the materials to a batch type mixer 10. The mixer is equipped with a screw type mixing blade 12, which also discharges the mixed materials. The mixer is provided with water sprays 14 through which water can be added. The mixed and dampened materials are discharged through door 16 into a refractory lined vessel 18. The latter is provided with a removable cover 20 containing a hot metal charging hole 22. Hot metal is conducted to the hole 22 by a hot metal runner 24. A pouring thimble 26 is provided at the forward end of the runner to receive hot metal from a ladle 28. The undersurface of the cover, the surfaces of the charging hole, the runner, and the pouring thimble are lined with a refractory 29. Treating vessel 18 is a cylinder mounted on trunnions 30 and equipped with conventional means for tilting between operating and discharge positions. The vessel is provided with several tuyeres 32 located near the bottom of the vessel; exhaust ports 34 are provided near the top of the cylinder.

The method of treatment consists of mixing 1 to 2 parts by weight of crushed open hearth slag and 1 to 3 parts by weight of blast furnace flue-dust with sufficient water, 5 to 15 per cent by weight of the total of slag and dust, to dampen, and then slowly pouring one part by weight of molten pig iron over the dampened mixture, while at the same time subjecting the materials to a blast of low pressure air. Treatment in this manner results in agglomerating the dust and slag into a mass of semi-metallic spongy lumps which, because of their porosity and strength, are ideally suited for subsequent treatment as a part of the burden in a blast furnace. Both physical and chemical interaction of the ingredients contribute to this result. The reactions are quite violent and must be conducted in a closed vessel for safety reasons. Moisture is essential; steam generated by the hot metal striking the dampened mixture serves to mix the reacting ingredients and to achieve the desired porosity in the product. Excessive water, however, must be avoided; the generation

Figure 2



of steam is too violent, and the available heat is limited. The heat requirements are supplied in large part from the sensible heat of the molten iron, but this is supplemented by burning of the iron by the oxygen in the blast. Burning of carbon by the oxygen affords an additional source of heat; carbon also acts to reduce some of the iron oxide in the dust, thus supplementing the bonding or cementing action of the molten iron.

METHOD OF CLOSING A TAP-HOLE FOR AN OPEN HEARTH FURNACE

U.S. 2,711,950, issued June 28, 1955 to Joseph S. Matasy, describes a method of closing a tap-hole in an open hearth furnace which simplifies the tapping of the furnace.

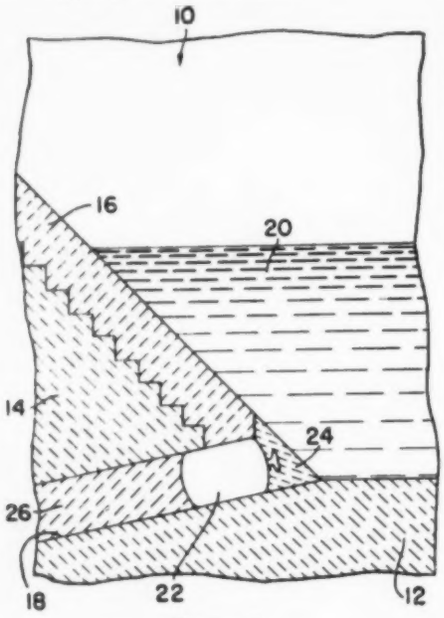


Figure 3

The patent describes four variants of the method, one of which is shown in Figure 3. The numeral 10 indicates an open hearth furnace having a bed 12 of highly refractory material (e.g. chrome ore or magnesite), a built up side or back wall 14 of similar material and a covering 16 of burnt dolomite or magnesite.

The tap-hole 18 is closed by moving a flexible bag 20 (made of asbestos fabric or wire fabric, and filled with raw dolomite) up to a position near the furnace end. Then a highly refractory material, e.g. burnt dolomite, is shoveled in from the front of the furnace to deposit a cover 24 over the bag. Burnt dolomite 26 is also shoveled and tamped into the rest of the tap-hole from the exit end. This causes the bag to expand into tight contact with the tap-hole. The discharge end of the tap-hole is then closed with a clay plug.

During the heat, the burnt dolomite 24 hardens and solidifies over the inner end of the bag. The heat which penetrates into the material in the bag partially gasifies the material, creating pressure toward the furnace end, thereby preventing the molten steel from penetrating any substantial distance down through the refractory layer 24. This greatly facilitates subsequent opening of the tap-hole.

In opening the tap-hole, the operator removes the clay plug at the discharge end and scrapes all the refractory material 26 out of the tap-hole by a rake, until the bag 22 is reached. The operator then carefully removes the relatively soft material contained in the bag, either breaking the bag open or pulling the bag out by a hook. The remaining thin wall of highly refractory hardened material is then readily broken through, e.g. by an oxygen burning pipe, or by a jet or torpedo. The resulting tap is more uniform than can otherwise be obtained.

COOLING SYSTEM FOR A BLAST FURNACE

U.S. 2,711,311, issued June 21, 1955 to David C. Affleck and Daniel E. Wise, and assigned to United States Steel Corp., describes an apparatus which provides cooling for the shell of a blast furnace by means of a continuous sheet of water flowing along the outer surface of the shell and protected from disturbance by air currents by means of a number of vertical outstanding ribs. A number of weirs slow down the flow of water between the ribs, preventing gravitational acceleration from causing a break in the continuity of the water film.

OPEN-HEARTH CHECKERWORK

U.S. 2,711,893, issued June 28, 1955 to Harry W. Walters, discloses an interlocking type of checkerwork for open hearth furnaces. Each brick has the same shape and, as shown in Figures 4 and 5, a completely symmetrical pattern is formed. The inventor claims that a very stable structure results, which is very readily installed.

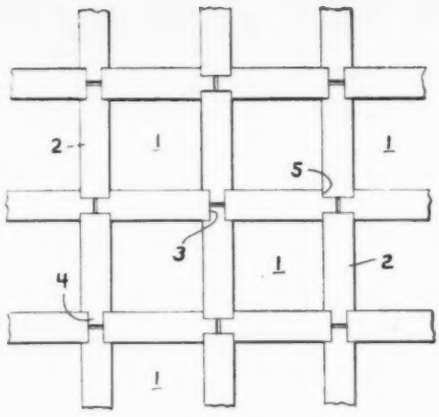


Figure 4

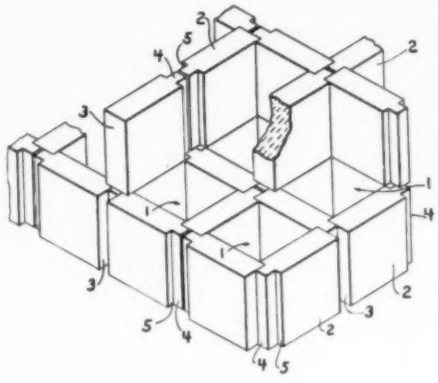


Figure 5

PRODUCTION OF BRIQUETTES OF IRON ORE

U.S. 2,711,951-2, issued June 28, 1955, by Howard F. West and John H. Veale, assigned to Illinois Clay Products Co., describes methods of producing iron ore briquettes for use in blast furnaces.

In U.S. 2,711,951, finely divided iron ore or taconite concentrate, preferably with about 15 per cent of coke breeze added, is molded and bonded with iron sulphate. The iron sulphate bonding agent may be provided by using spent pickle liquor or a small amount of concentrated sulphuric acid. After dry pressing, the bricks so produced are heated to 380 F to remove excess moisture and to complete the bond.

In U.S. 2,711,952, the molded bricks are heated in a reducing atmosphere at 2000 F, to reduce 75 per cent of the iron ore to metallic iron, and partly fusing the brick. This reduces void space and therefore increases thermal conductivity.

METHOD OF REDUCING SULPHUR IN MOLTEN IRON AND STEEL

U.S. 2,711,954, issued June 28, 1955 to Howard F. West and John H.

. . . and all the fixin's—thanks to BRICK

On the table at last, after hours of tantalizing fragrances wafting from the kitchen. Another mission completed by brick.

Brick built the ships and trains and trucks that brought the "makin's". Refractory brick. It created the steel for the stove and the carving knife . . . the heat for the oven. For everything that's made or moved owes its existence to the refractory brick which contain the flames of industry.

Making these refractories is an exacting science. When you deal with temperatures of thousands of degrees, you can't afford to guess. So General Refractories operates the world's largest and most modern refractories research laboratory, constantly seeking progress and perfection.

With plants and facilities strategically located throughout the country, General Refractories provides industry with a complete refractories service dependably . . . economically . . . everywhere.

GENERAL REFRACTORIES COMPANY
Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE STEEL INDUSTRY

OLIVE HILL BF and OLIVE HILL HI-FIRED brick rank high in any list of prominent and widely used brands of blast furnace refractories. Manufactured from dense-burning Kentucky flint fire clays by Grefco's unique manufacturing processes, OLIVE HILL brick set a standard for blast furnace refractory quality and workmanship.

Grefco processing of OLIVE HILL brick entails:

1. Careful selection, testing, stockpiling and blending of fire clays to insure uniform raw material quality.
2. Grinding and screening to prescribed formula to promote high density of product.
3. Efficient deairing during brick forming, also to promote density and proper physical structure.
4. Careful firing to exacting temperature schedules to yield uniform high quality brick.
5. Close inspection of final product with gauging and sorting of brick to close size tolerance.
6. Quality control by statistical analysis procedures for the manufacturing processes.

In service, OLIVE HILL blast furnace brick, both BF and HI-FIRED, have produced many splendid performance records in the past. OLIVE HILL linings in presently operating furnaces, are giving outstanding performance and are more than meeting the increasing requirements of the expanding American Iron and Steel Industry.

GENERAL REFRACTORIES

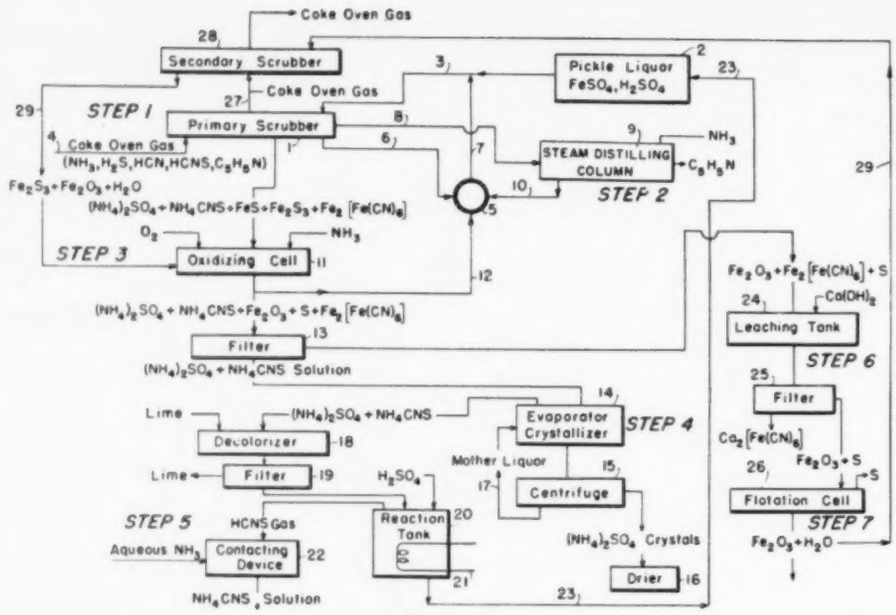


Figure 6

Veale, and assigned to the Illinois Clay Products Co., discloses a method of reducing the amount of sulphur in molten iron or steel in a ladle by means of a special refractory lining in the ladle.

The refractory consists of fire clay, carbon, and acid aluminum sulphate as a chemical (unfired) bonding agent. The bonding agent is prepared by reaction between concentrated sulphuric acid and the alumina in the fire clay. According to the inventors, the refining action is threefold: (1) agitation of molten metal by the reaction between the FeO in slag and carbon in the refractory; (2) creation of reducing conditions favorable to elimination of sulphur, both the carbon of the refractory and the CO formed acting as reducing agents, i.e.

$$FeS + CaO + C \longrightarrow CaS + Fe + CO$$

$$FeS + CaO + CO \longrightarrow CaS + Fe + CO_2$$

and (3) conversion of the sulphur to SO_2, by release of SO_3 from the refractory at the high temperatures created by the metal, i.e.

$$2\,SO_3 + FeS \Longrightarrow Fe + 3\,SO_2$$

PARTING COMPOSITION

U.S. 2,711,966, issued June 28, 1955 to Thomas T. Watson and Albert Riggall, assigned to Lukens Steel Co., describes a number of parting compositions for use in the pack-rolling of metal ingots or slabs.

The parting compositions include an infusible nondecomposable inorganic compound ground to —100 mesh, with a binder consisting of cellulose acetate or nitrate dissolved in a volatile non-aromatic solvent. For example, cellulose nitrate dissolved in ethyl acetate may be used as the binder, and chromium sesquioxide may be the inorganic compound.

SALT BATH FOR CARBURIZING OR CYANIDING STEEL

U.S. 2,711,981, issued June 28, 1955 to Frederick D. Waterfall and Robert L. Hewson, assigned to Imperial Chemical Industries Ltd., describes an improved fused salt bath for carburizing or cyaniding steels and alloy steels.

The bath consists of a predominant amount of sodium and potassium chlorides, a smaller quantity of sodium cyanide, and a still smaller amount of silicon powder.

An advantage claimed is that the salt is readily removed from the metal, because of its high water solubility, while still giving an excellent carburized case. Further, it is claimed that there is no tendency to leave a soft surface layer of austenite in the case of alloy steels.

PREPARATION OF FERROUS METAL FOR COLDWORKING

U.S. 2,712,511, issued July 5, 1955 to Gilbert H. Orozco and Richard F. Roy, assigned to the Pennsylvania Salt Manufacturing Co., describes compositions for preparing ferrous metals for cold forming operations. The compositions are solid, and act as lubricants.

For thin films, the following composition is preferred: 10 parts oxalic acid, 10 parts phosphoric acid, 1 part hypophosphorous acid, 1000 parts water; and for thick films: 25 parts oxalic acid, 5 parts phosphoric acid, 1 part hypophosphorous acid, 1000 parts water.

The ferrous stock is subjected to the aqueous solution by dipping for 3 minutes at 200 to 205 F. A microporous film forms which is chemically bonded to the metal.

PROCESS FOR USING SPENT LIQUOR FOR RECOVERING VALUES FROM COKE OVEN GAS

U.S. 2,712,980, issued July 12, 1955 to Richard D. Hoak, describes a process for using spent pickle liquor for the recovery of values from coke oven gas.

As shown in Figure 6, the following products are obtained: (1) ammonium sulphate, (for fertilizer), (2) iron oxide (for use in blast furnace), (3) elemental sulphur (for manufacture of sulphuric acid), (4) ferrocyanide (for pigment manufacture), (5) pyridine (raw material for organic chemical industry), and (6) ammonium thiocyanate (for weed killers).

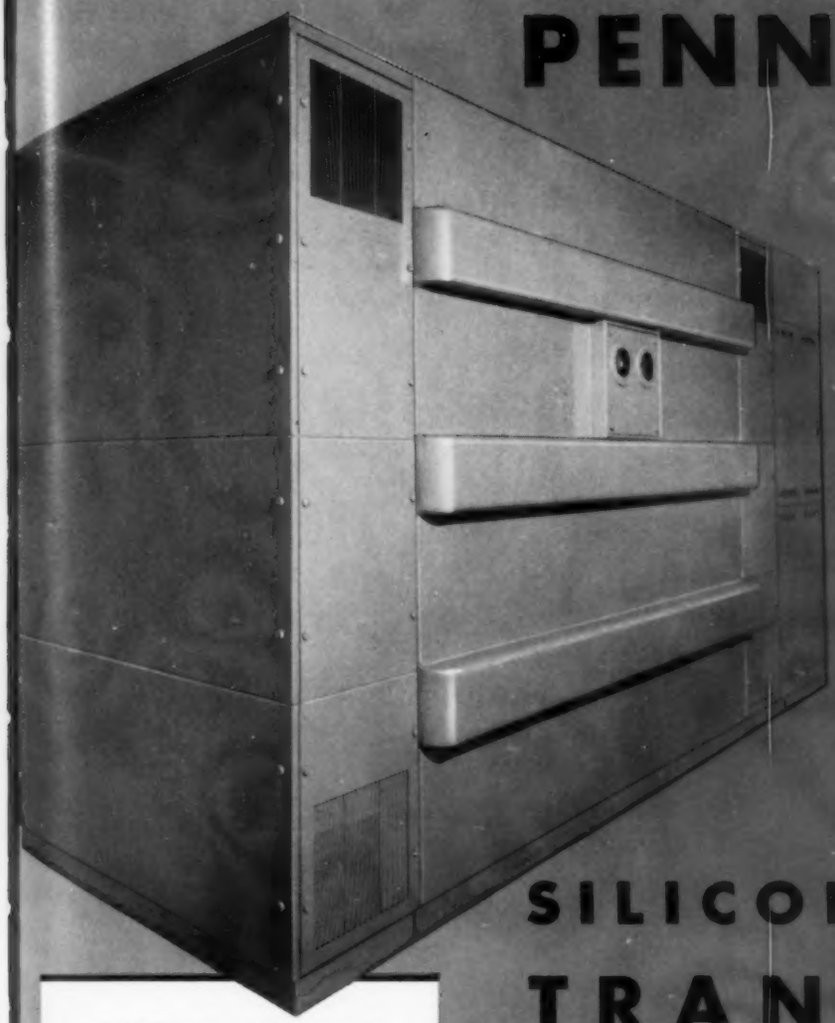
OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,711,006	6/21/55	Unloader for tube mills	The Etna Machine Co.
2,711,248	6/21/55	Concentration of iron ores	Jones & Laughlin Steel Corp.
2,711,309	6/21/55	Heat treating apparatus	Selas Corp. of America
2,711,368	6/21/55	Reducing oxidic iron ore with gaseous hydrocarbons	Esso Research & Engineering Co.
2,711,809	6/28/55	Rolling mill switching apparatus	Jones & Laughlin Steel Corp.
2,711,815	6/28/55	Endless metal belts	United States Steel Corp.
2,711,953	6/28/55	Treating nodular iron	Ford Motor Co.
2,711,979	6/28/55	Cutting stainless steel	National Cylinder Gas Co.
2,712,205	7/ 5/55	Abrading roll for surface grinding of metal strip	Crucible Steel Co. of America
2,712,463	7/ 5/55	Operating device for the latching means of coke oven doors	Koppers Co., Inc.
2,712,468	7/ 5/55	Cone bottom charging bucket for cupolas	Whiting Corp.

PENNSYLVANIA

suggests you consider

Fire and Explosion resistant



2000 Kva Group 3 Sealed-in Nitrogen Dry Type Transformer. H. V.—2400Δ volts. L. V.—480Δ volts. Three Phase. One of the largest Silicon-Insulated transformers ever built.

SILICONE-INSULATED TRANSFORMERS for Indoor Unit Substations

When planning an indoor unit substation, plan to install the safest substation transformer ever developed — a Pennsylvania Silicone-Insulated, sealed-in-nitrogen 150°C. Rise Dry Type Transformer.

Since oil-filled transformers constitute a fire risk, they cannot be used safely indoors unless expensive vaults and barriers are erected. And though askarel-filled transformers are installed indoors without vaults or fire barriers, they have been known to give off toxic HCl vapors under arcing. This constitutes a hazard to personnel. Therefore, Askarel transformers must be provided with gas absorbers or they must be vented to the outside air.

Pennsylvania Silicone-Insulated Transformers can be installed indoors "as is", without expensive vaults and other costly safety devices because inherently, they are the safest transformers ever developed. But safety is only one of their many advantages, for these "safest" dry type transformers also feature *smaller size, greater overload capacity, decreased cooling time, resistance to dirt and moisture, and minimum requirements for maintenance.*

If you want to know more about the Pennsylvania Silicone-Insulated Transformer — formerly called Class H — see your Pennsylvania representative or write to Pennsylvania Transformer Company, Box 330, Canonsburg, Pennsylvania.

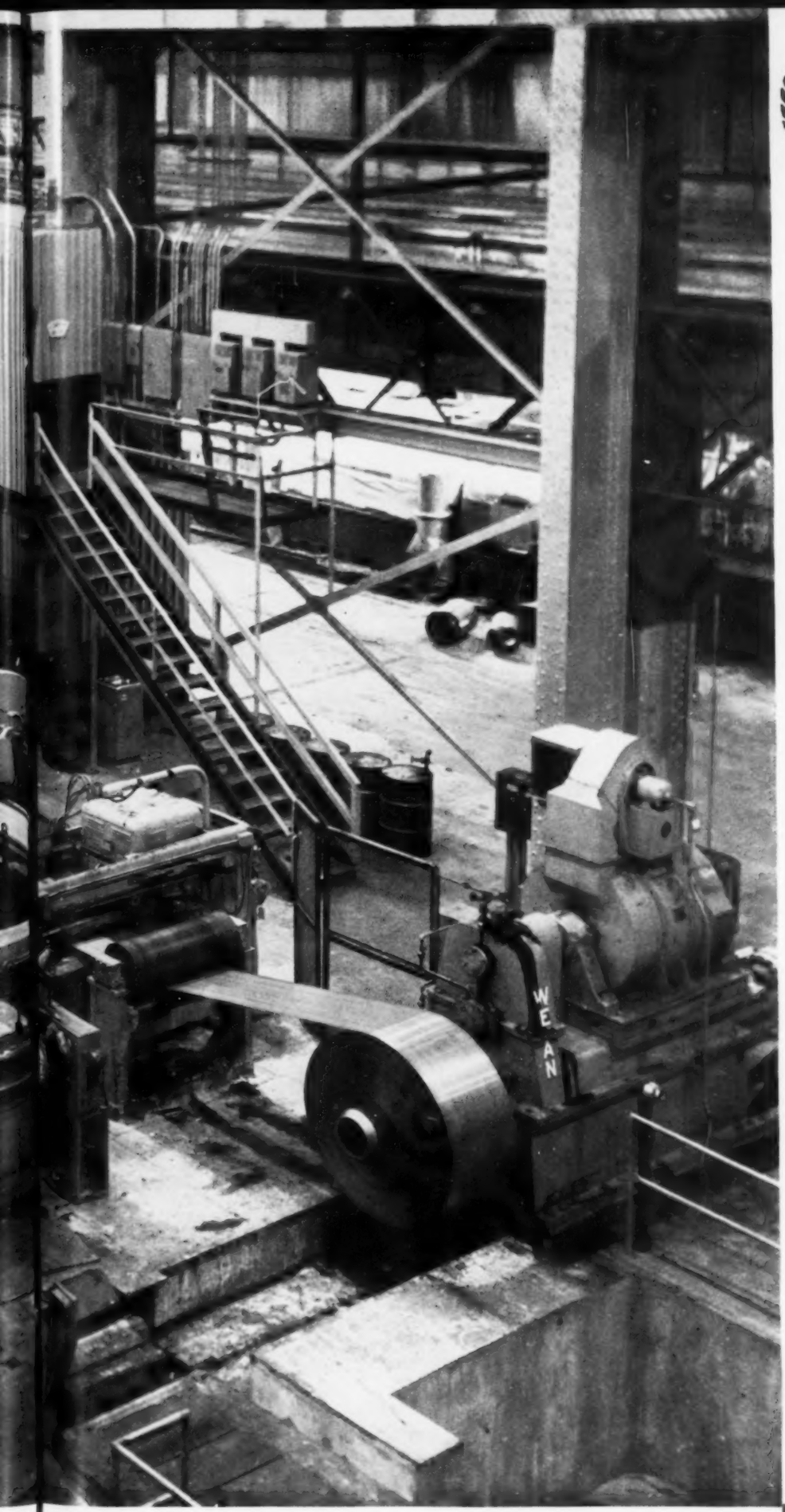
PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division • CANONSBURG • PENNSYLVANIA

pt

The WEAN ENGINEERING Company, Inc.

WARREN, OHIO



Illustrations show the modern electrolytic cleaning and tinning line installed at the Aliquippa, Pa., works of Jones & Laughlin Steel Corporation.

WEAN

MODERN ELECTROLYTIC CLEANING AND TINNING LINES

The proficiency of the Wean Engineering Co., Inc. in creating the machinery to efficiently process steel has long been recognized throughout the steelmaking industry.

The Wean organization prides itself in an engineering staff accomplished in designing highly successful processing lines of every approved type. Many of the features of modern day lines, now considered standard equipment, were initiated at Wean.

It's this vast experience and creative ability in producing processing lines that naturally guided Jones & Laughlin in selecting Wean as the supplier of their modern electrolytic cleaning and tinning lines.

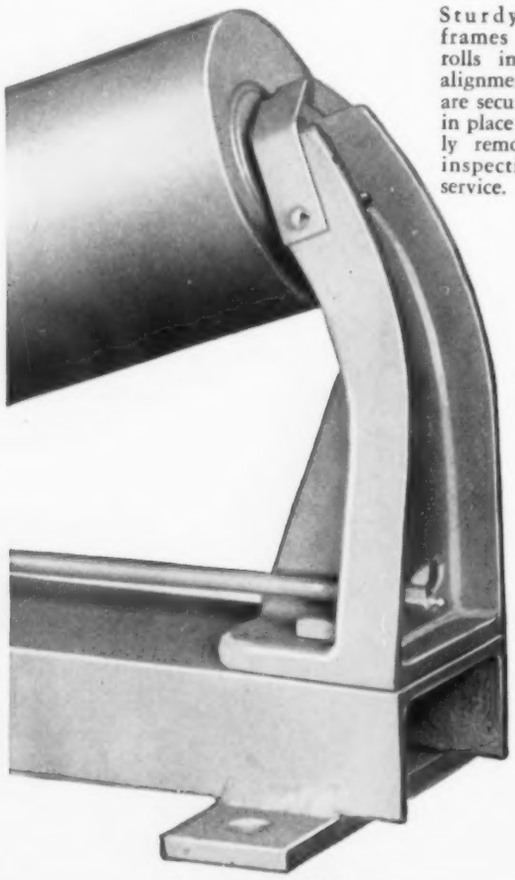
When next considering your sheet, tin or strip mill operation, why not talk with Wean Engineers — one of America's foremost designers and producers of complete processing lines.

SPECIALISTS IN SHEET, TIN AND STRIP MILL EQUIPMENT

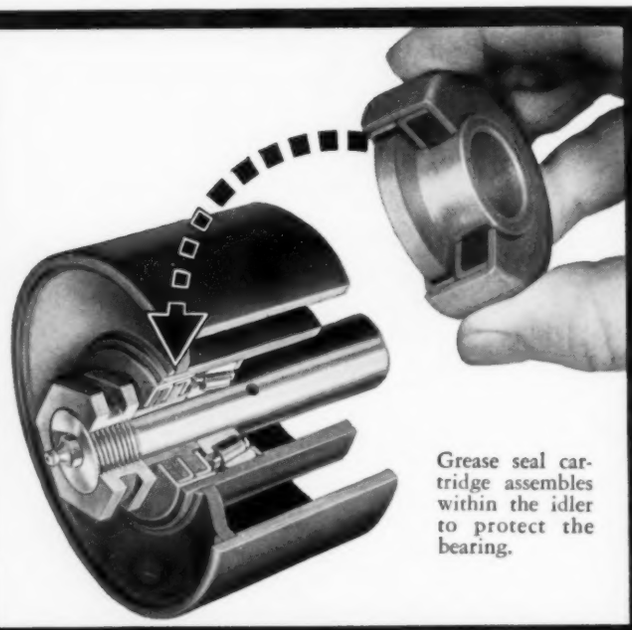
Today's simplest IDLER GREASE SEAL is also the best-performing

THE cartridge grease seal used on Link-Belt belt conveyor idlers provides the effectiveness of multiple sealing with the convenience of a single unit. A contact seal of laminated felt and neoprene combined with a labyrinth keeps dirt out, grease in. And the grease itself within the labyrinth further prevents entrance of dirt or other matter. What's more, no springs or loose washers are involved . . . there's no chance for metal-on-metal friction. The entire assembly comprises a rugged, compact "cartridge."

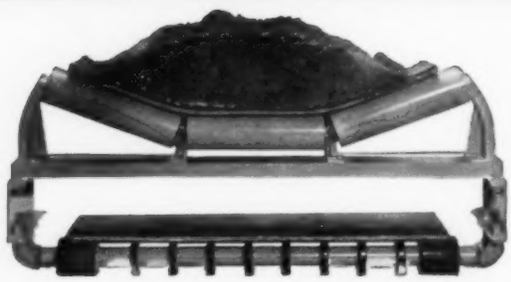
Simplicity is only one of the big advantages you get with Link-Belt idlers. Check the others below. For complete facts ask your nearby Link-Belt office or authorized stock-carrying distributor for a copy of Book 2416. It lists over 500 sizes in 34 types, including troughing, variable troughing, flat belt, belt training and rubber cushion idlers.



Sturdy, rigid frames support rolls in perfect alignment. Rolls are securely held in place but easily removed for inspection and service.



Grease seal cartridge assembles within the idler to protect the bearing.



You'll find these 6 features throughout industry's most comprehensive idler line

1. **HUSKY, HIGHEST QUALITY BEARINGS,** free and easy turning, assure maximum life, minimum belt-wear, low power consumption. Concentricity is secured by unit mounting of bearings in a heavy-wall center tube.
2. **SAFE, CONVENIENT GREASE FITTINGS** protected by flange ribs of support brackets provide ease of lubrication—lubrication for longer life.
3. **CONCENTRIC ROLLS** have smooth surfaces and rounded edges. Machine-made, continuous welds prevent entrance of dirt and moisture.
4. **HOP-FREE ROTATION** is assured by close tolerances, press fits and precision assembly from shaft to shell.
5. **STRONG, RIGID FRAMES** support rolls in perfect alignment. Rolls are securely held in place but can be easily removed for inspection and service.
6. **GROOVED HEX NUTS** lock into malleable brackets, creating bridge truss effect—prevent shaft rotation and bracket spreading under load.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,805

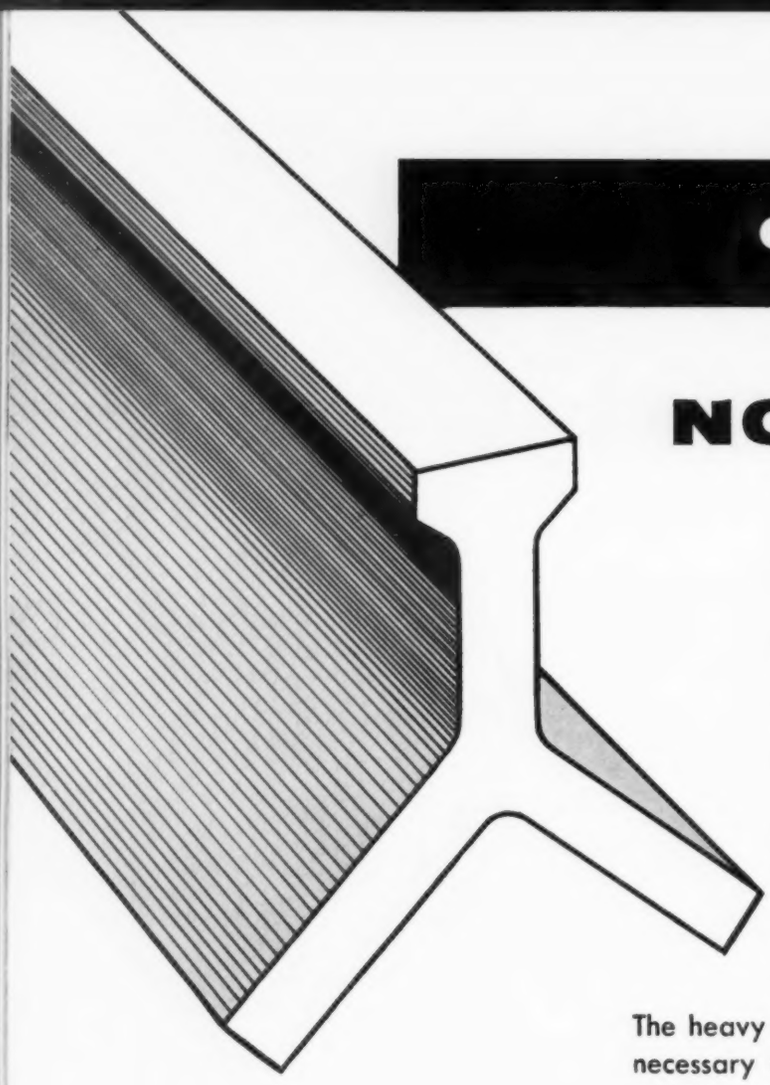
"More Combustion Information with Cities Service Heat Prover"

says Keystone Steel & Wire Co.

The Keystone Steel & Wire Company of Peoria, Illinois, is one of many companies now taking advantage of the portable Heat Prover . . . the remarkable combustion analysis instrument supplied and maintained free by Cities Service.

Says Keystone official, Glen Sharp: "For day to day use on the shop floor, the Heat Prover is, in my opinion, the most convenient and practical device available today. We use it throughout the plant for practically every kind of combustion analysis. It is particularly valuable where multiple fuels are used, in cases where both combustibles and free oxygen are present in the flue gas, and again, where normal combustion products are involved in the process itself. It gives simultaneous readings of oxygen and combustibles, and permits continuous explorations of the sampled area if desired. All these advantages make the Heat Prover ideal for Open Hearth work."

The Cities Service Heat Prover is not a product you buy, but a service we supply . . . free! For more information, contact your nearest Cities Service office or write Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.



CLEVELAND CRANE

NOW AVAILABLE

PROVIDE FULL POWER REQUIREMENTS • ELIMINATE PRODUCTION HOLD-UPS • CUT ELECTRICAL MAINTENANCE

Especially designed for use on Cleveland Cranes to provide the finest electrification possible, aluminum *inverted-Y* conductors are now being made available for application on all makes of cranes and runways.

The heavy bars, with trouble-free sliding collector shoes and necessary fittings, will be furnished for installation by the purchaser.

First introduced in 1948, Cleveland Crane aluminum *inverted-Y* conductors have been fully proven with hundreds of thousands of feet on hard-service installations in many mills and plants.

It is now possible for you, too, to have the finest in crane electrification. Your inquiry is invited.

CLEVELAND CRANE ALUMINUM *INVERTED-Y* ELECTRIFICATION

Offers you many advantages...

- **HIGH CAPACITY**—available in 300-500-1000 ampere and larger sizes.
- **LOW VOLTAGE DROP**—eliminates need for booster lines—excellent for sensitive control circuits.
- **LOW REACTANCE**—ideal for A.C. circuits.
- **LIGHT WEIGHT**—reduces weight of supporting equipment.
- **RIGID SECTION**—satisfactory for long spans.
- **CORROSION RESISTANT**
- **FLOATING HANGERS**—virtually eliminate need of expansion joints—minimize insulator breakage.
- **NON-ARCING COLLECTOR SHOES**—high capacity sliding type—keep conductors polished for good electrical contact.
- **COUNTERWEIGHT-TYPE COLLECTOR**—assures permanent uniform pressure.
- **TWO MOUNTING STYLES**—available for overhead or side mounting.
- **EASY ERECTION**—quickly installed by your own men.
- **PARTS AVAILABLE**—large stock of parts assures quick delivery.

ALUMINUM *INVERTED-Y* CONDUCTORS

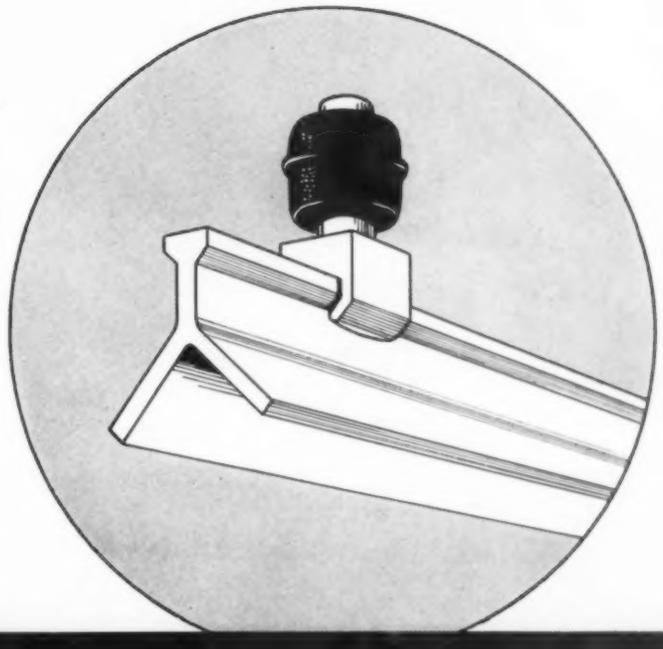
FOR *all* CRANES

First time advertised...
for application on other than Cleveland Cranes

BELOW
Side-mounted conductor bars with pantograph-type underrunning collector shoes. Designed to maintain positive electrical contact regardless of conductor bar irregularities.

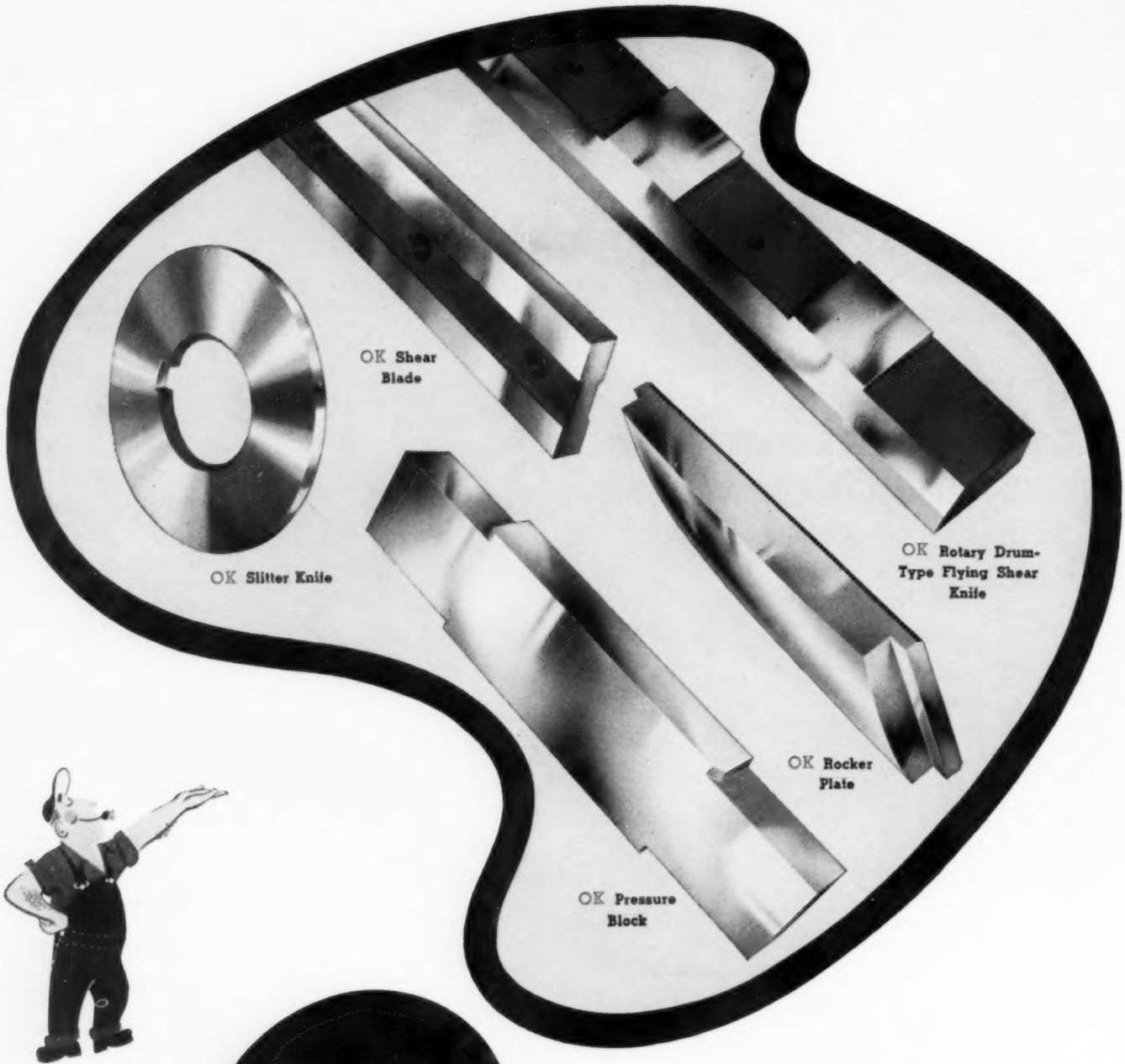
BELOW
Conductor bars are readily mounted overhead. Hangers are especially made to permit conductors to float, obviate need of expansion joints and eliminate strain on insulators.

Counterweight-type collector maintains constant pressure of sliding shoes on conductor bar without springs. Because of pantograph motion and ball socket connection at shoe support, positive contact will be maintained even if bar becomes misaligned in either horizontal or vertical plane. The two shoes are easily replaced by loosening one stud bolt.



THE CLEVELAND CRANE & ENGINEERING CO.

5031 EAST 289th ST. WICKLIFFE, OHIO



it's OK ...let'er go!

In hundreds of Mills and Fabricating Plants throughout the nation, Wear Plates and Machine Knives made by the Ohio Knife Co. are delivering extra long service life with resultant production cost savings in the toughest services.

1. **Only the finest tool steel is used conforming to our exacting metallurgical standards.**
2. **Our exclusive heat treating process assures the proper uniform hardness and temper to best suit your individual cutting or wear problems.**
3. **Precision grinding of all pieces to ± .00025 or less if you require.**

For free bulletin, "SLITTING—A Basic Guide for the New Operator", write Dept. 10-Z.

Manufacturers of
Hardened Spacers • Ways • Gibs • Ball Races • Slitter Knives • Wear Strips • Shear Blades • Work-Rest Blades Cut-Off Blades • Bronze Ways

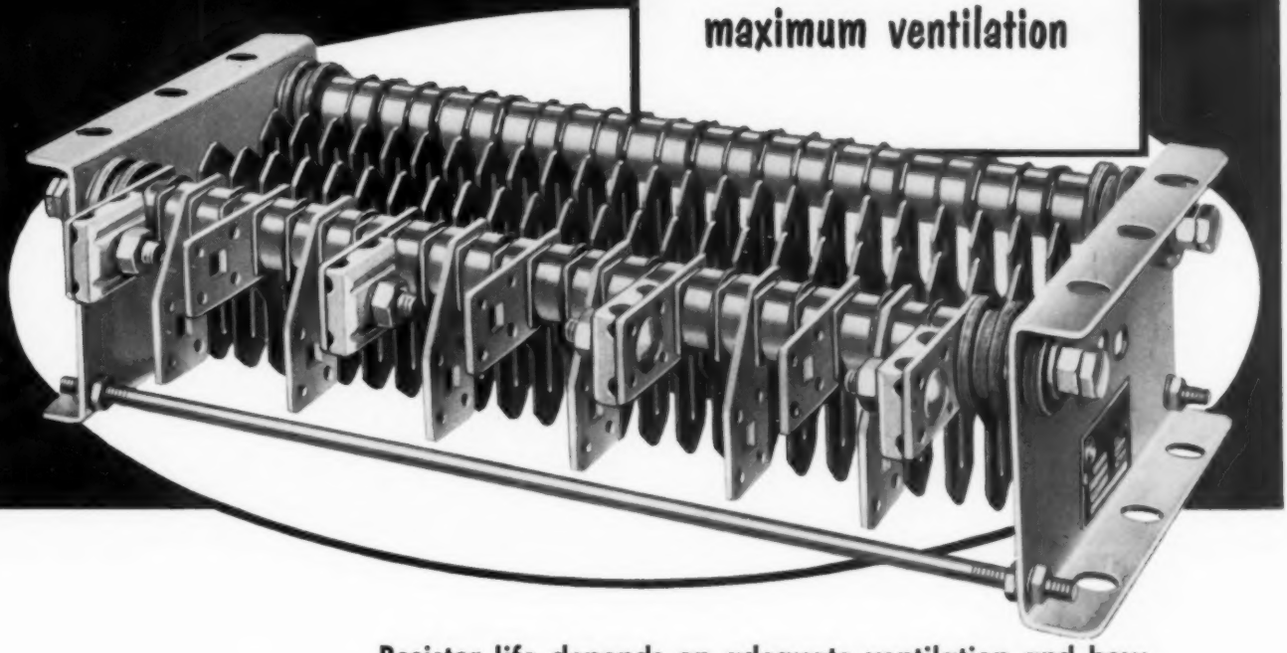
GO WITH OHIO GREEN

THE OHIO KNIFE CO.

CINCINNATI 23, OHIO

Resistor life depends on adequate ventilation.....

Patented P-G Grid Design assures maximum ventilation



P-G has BOTH!

STANDARD Resistors

WELDED Resistors

Write for Bulletins

Resistor life depends on adequate ventilation and how efficiently heat may be dissipated . . . P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat throughout the grid area. (Note illustration.) . . . Since heat is rapidly and evenly dissipated, hot spots fail to develop and longer resistor life is assured . . . For a nonbreakable resistor (only steel and mica used) specify P-G on your next application.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

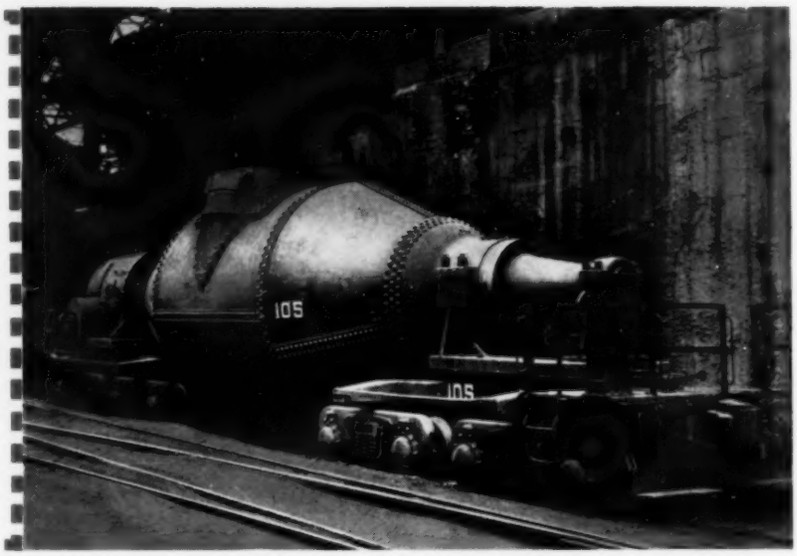
221 WEST THIRD STREET, CINCINNATI 2, OHIO

Mixer-Type HOT METAL CARS

There are many advantages in using Treadwell cars. For example: Heat loss is much less than from open-top hot metal cars. This is true of both iron carried and ladle lining.

Practically all users claim no ladle skulls with Treadwell Mixer Cars. Reports indicate varying amounts of ladle skulls with open-top ladles — 3% of total iron handled is a conservative figure.

Many plants using these cars do not have stationary mixers, but hold the iron in the ladle until mixing time. This practice results in an average conservation of iron heat of about 150° — also saves operating expense of stationary mixer.



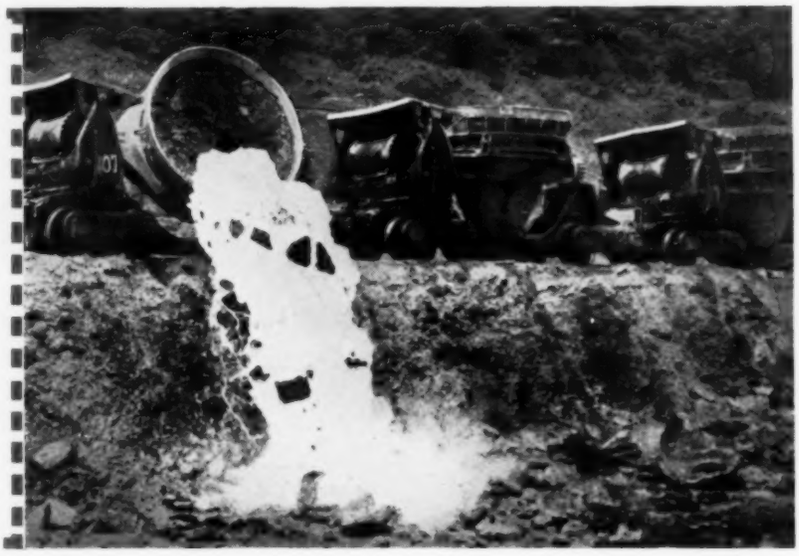
ABOVE: Treadwell 193-ton mixer car at Aliquippa Works.
BELOW: A few of the forty-six 340 cu. ft. capacity cinder cars in action.

CINDER CARS

Treadwell cinder cars are made in a wide variety of designs to suit individual needs, of either cast or welded steel construction.

They can be built to carry from one to four pots, and can be supplied with air, steam or electric dumping devices, or can be arranged for dumping by crane.

Cars can be built to dump to either or both sides of the track. No change in mechanism is required; direction can be reversed automatically. Front flush and end dump cars are also available.



J & L'S ALIQUIPPA WORKS DEPENDS ON

TREADWELL HOT METAL AND CINDER CARS

Shown above are a few of the 13 Treadwell Hot Metal Cars, and 46 Cinder Cars, in service at the Aliquippa Works of Jones & Laughlin Steel Corporation. Listed, are the advantages and design features which make these cars so popular with J & L, and with most other major metal producing plants.

A recent survey, for example, showed that Treadwell Mixer Cars are handling 51% of the combined production of the United States and Canada, exclusive of ferro-manganese and the output of smaller blast furnaces.

More than 2000 Treadwell Cinder Cars have been placed in service in the United States, Canada and overseas. The many repeat orders attest to the efficiency and economy of operation of these cars.

Next time you are in the market for Hot Metal or Cinder Cars, consider Treadwell's broad experience. In the meantime, we would like to send details of the cars mentioned. Just say the word.

M. H. TREADWELL COMPANY, INC.
140 Cedar Street, New York 6, N. Y.
1015 Farmers Bank Bldg., Pittsburgh 22, Pa.
208 So. La Salle Street, Chicago 4, Ill.

TREADWELL
HOT METAL AND CINDER CARS

TR-19

IN THE ALIQUIPPA WORKS OF JONES & LAUGHLIN STEEL CORP.

This Heyl & Patterson Coal Barge Unloader and Handling System Has a Capacity of 1500 Tons Per Hour.

Unloader Operation Is Controlled By One Man

The giant coal barge unloader handles J&L's Aliquippa Works normal daily requirements of 10,500 tons of coal.

As the loaded barge is moved slowly under the unloader, coal is hoisted by a continuous elevator comprised of two lines of 7′ wide, ½ ton capacity buckets. These buckets carry the coal to a hopper at top of the unloader, from which it is conveyed by a 60″ wide belt to the surge bins.

The unloader removes the coal so completely that clean-up is not needed in the barge at any time.

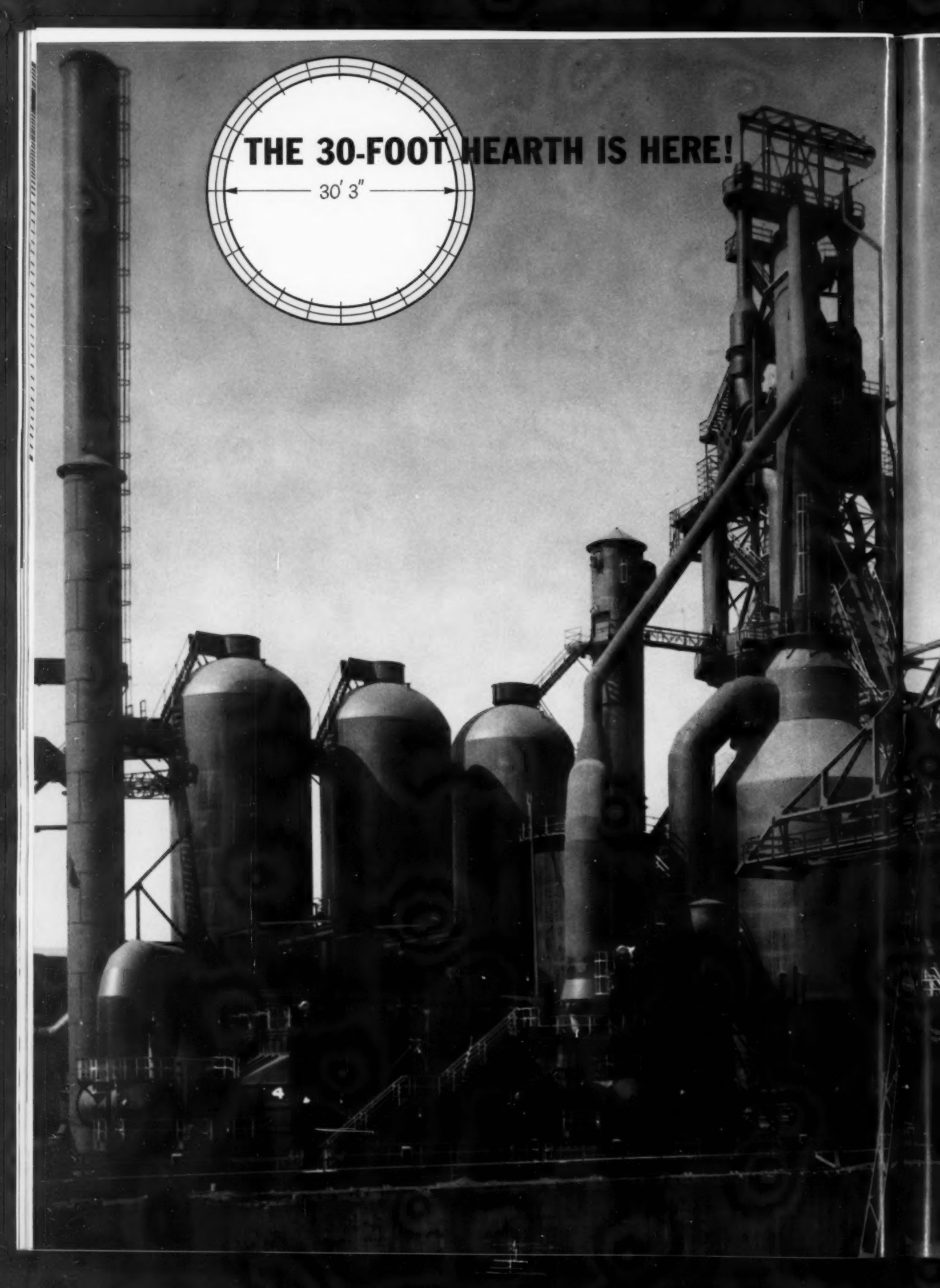
When being unloaded the coal barge is protected from drifting by snubbing lines and barge positioners. The independent movement of the positioners enables the operator to keep the barge in precisely the right position at all times. The positioners are also used to push the barge away from the dock after unloading.

All movements of the barge and bucket elevator unloader are finger-tip controlled by one man. This man, located in a glass enclosed cab, has clear vision of all operations of barge movement and unloading.

Heyl & Patterson is now building a similar Coal Barge Unloader and Handling System of greater capacity for Jones & Laughlin Steel Corporation's Coal Preparation Plant at East Frederickstown, Pa.

Heyl & Patterson
INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.
PHONE COurt 1-0750


THE 30-FOOT HEARTH IS HERE!
30' 3"

World's largest blast furnace built for Great Lakes Steel

The 30-foot blast furnace has been a more elusive goal to steelmakers than the 4-minute mile to runners and the sound barrier to fliers.

Back in 1918, the steel industry hailed the construction of the first furnace with a 20-foot hearth . . . and set its sights higher. Now, 37 years later, the 30-foot hearth is here.

Proud possessor of the world's largest blast furnace is the Great Lakes Steel Corporation of Detroit, Michigan—a division of National Steel Corporation. Proud designer and erector of this new giant is the Freyn Department of Koppers Engineering and Construction Division.

Great Lakes Steel's new Blast Furnace "A" has a hearth diameter of 30 feet, 3 inches, and a total interior volume of 64,435 cubic feet. This new furnace soars 260 feet above the yard level. Total weight of this mammoth iron-maker, when fully charged, is about 12,800 tons.

Blast Furnace "A" was blown in last June. Engineers predict that, as operating experience develops, the furnace may average 60,000 net tons of iron per month . . . and break the world's record for production.

Designing and constructing blast furnaces is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

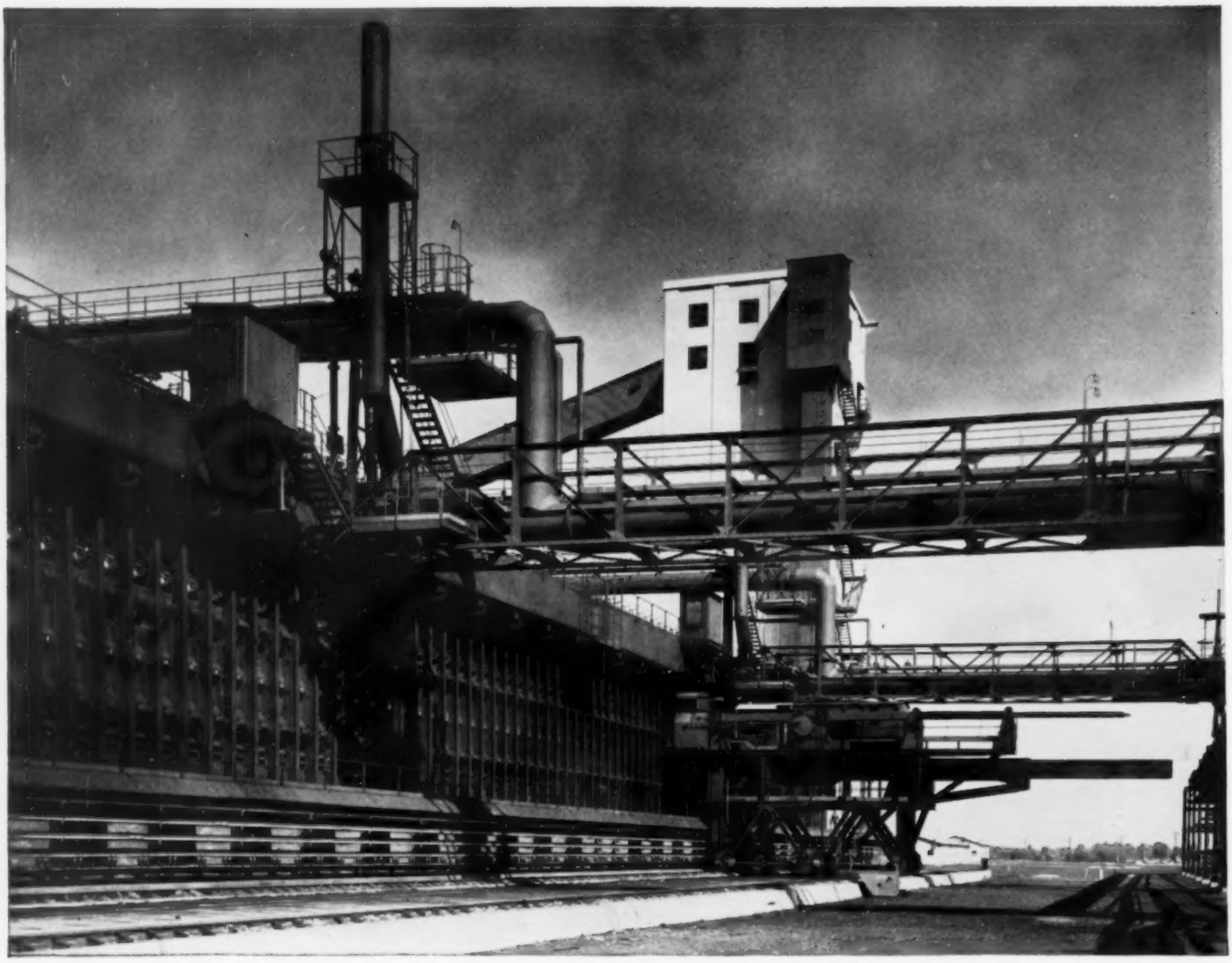
KOPPERS®

Engineering and Construction Division

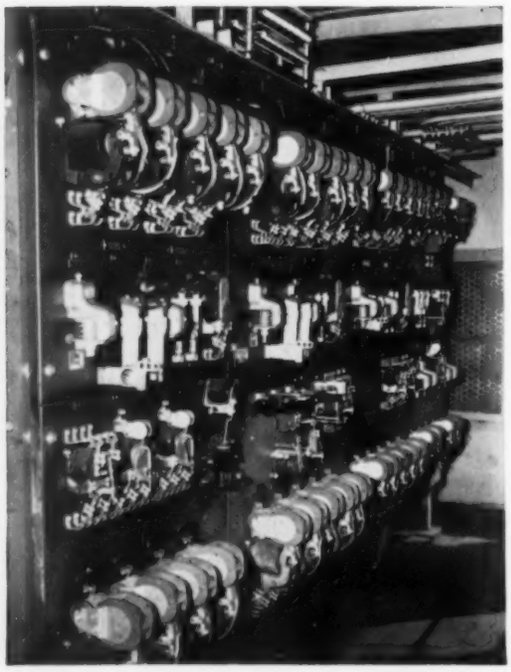
FREYN DEPARTMENT

KOPPERS COMPANY, INC., PITTSBURGH 19, PENNSYLVANIA

Great Lakes Steel's new blast furnace at Zug Island, River Rouge, Michigan. With a hearth diameter of 30 feet, 3 inches, this is the world's largest blast furnace. A realistic pig-iron production target is 60,000 tons monthly.



Giant pusher for 76 coke ovens is CLARK CONTROLLED



Coke is discharged from this battery of 76 ovens—almost 300 feet long—at the rate of 58 tons per hour. The enormous Clark-controlled pusher moves from oven to oven on a regular schedule, emptying each as it becomes ready . . . Designed and built by the Wilputte Coke Oven Division of Allied Chemical and Dye Corporation of New York, the 300,000 pound pusher depends on Clark apparatus for its precise, dependable operation. The six separate motors, totalling 175 HP, are controlled by a Clark Bulletin 9300 Coke Pusher Control. The special Clark Control Panel is shown at the left.

The CLARK CONTROLLER Company

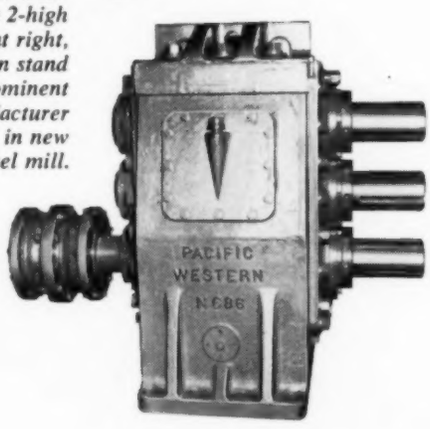
Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA . . . CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

WESTERN GEAR rolling mill drives ...rugged as Gibraltar!

Western Gear 2500 HP Model S-87-MS speed reducer 5.7:1 ratio utilizing double helical staggered tooth gears.



Above, Western Gear designed double 2-high pinion stand, and at right, single 3-high pinion stand manufactured for prominent mill equipment manufacturer for installation in new Italian steel mill.

Western Gear pinion stands, gear drives and other machinery for application in steel rolling mills are backed by experience accumulated since 1888 in the design and construction of mechanical power transmission equipment of every description. It's your guarantee of ruggedness and trouble-free production day in and day out. Anti-friction bearings provide for rock-steady, vibration-free operation so essential to maintain high standards of accuracy and finish. And this same precision helps prolong the life of related machinery, too! Removable end plates on Western Gear pinion stands enable lifting entire gear train for easy inspection without removing housing from bed plate mounting.
To maintain top quality output with a minimum of downtime and overhead, insist on Western Gear drives for rolling mill application.

For recommendations on the installation of new equipment or the replacement of obsolete or worn units, write today. Our engineers will be glad to offer their help and experience. Address General Offices, Western Gear, P.O. Box 182, Lynwood, California.

"The difference is reliability" ★ Since 1888 5570

WESTERN GEAR
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

It's Allis-Chalmers . . .

Motors, M-G Sets, Control, Switchgear... Dependable Allis-Chalmers Electrical Equipment Plays an Important Role in Steel Mill Expansion Programs

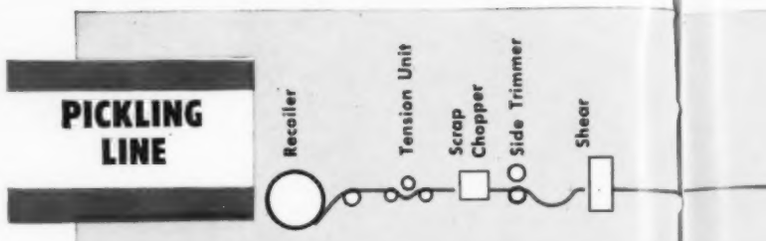
Demand for specialized steel remains at a record high. Steel producers are meeting the challenge with improvements on existing processing lines, or installation of new facilities for pickling and annealing operations.

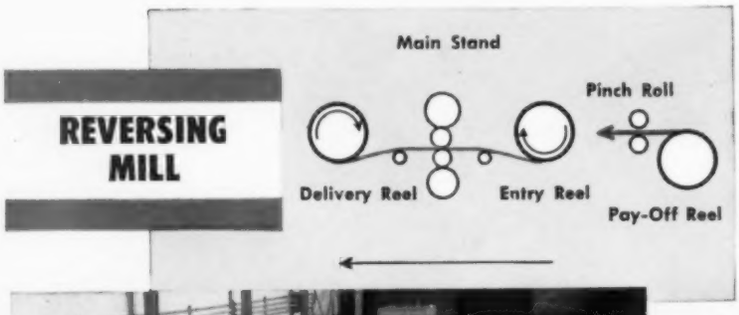
A recent installation of this type in an eastern steel mill featured Allis-Chalmers motors, m-g sets, control and operating stations, and switchgear throughout.

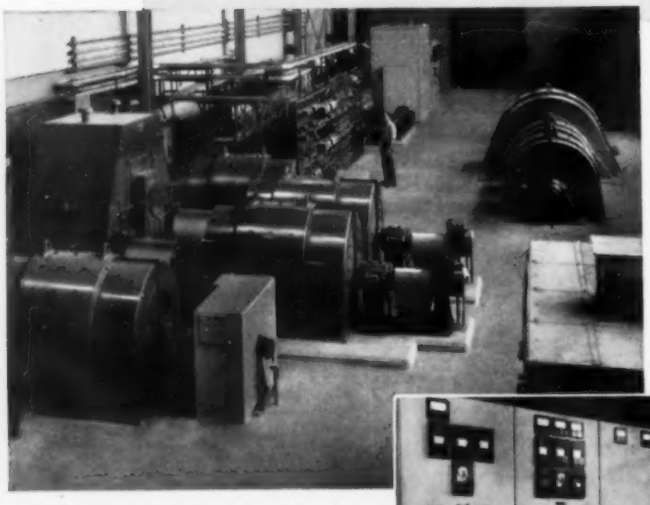
Allis-Chalmers equipment was chosen for this duty because of its record of quality, economy, durability . . . proven in years of heavy-duty steel mill operation.

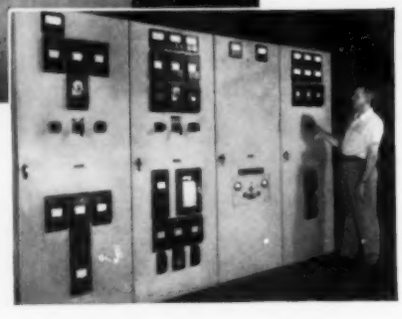
Take advantage of Allis-Chalmers wide range of equipment and service. For help in planning new facilities or modernizing present plants, contact the A-C office in your district, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4872

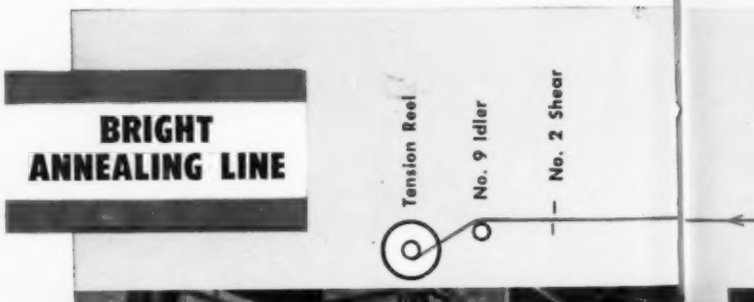








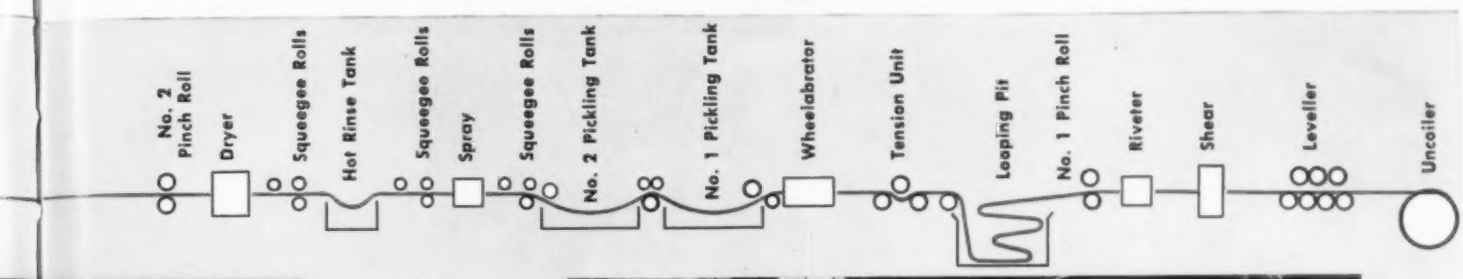
Overall view of new reversing mill motor room showing main motors, m-g sets, control, and 11,000/480-volt substation. Inset shows Allis-Chalmers 15-kv high voltage switching equipment for the motor-generator set and substation.

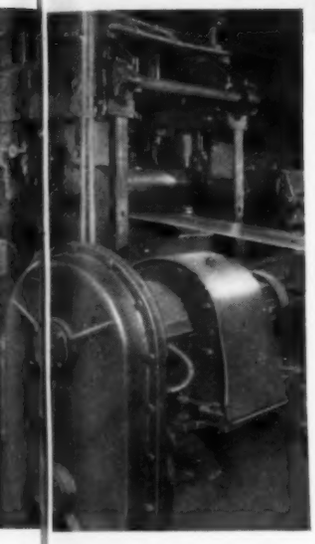


Delivery end of new annealing line. Allis-Chalmers desk-type operators' control stations, as shown here, are used throughout these modern new facilities.

ALLIS-

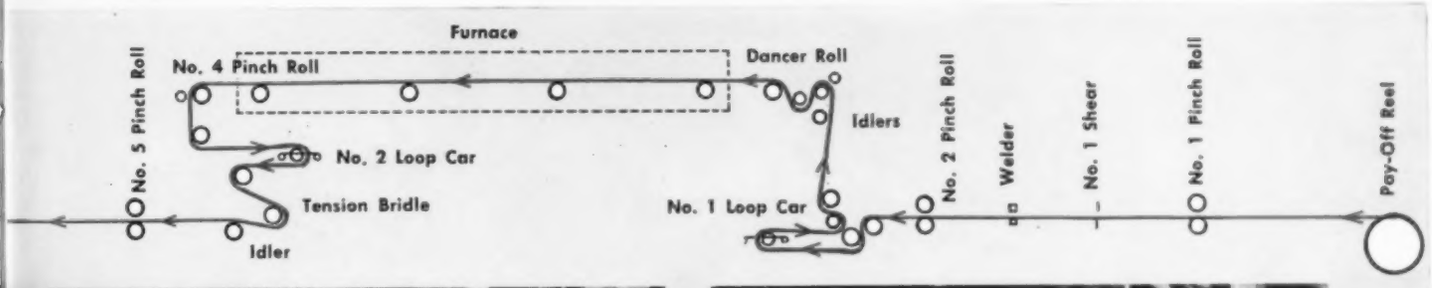
. All Along the Line

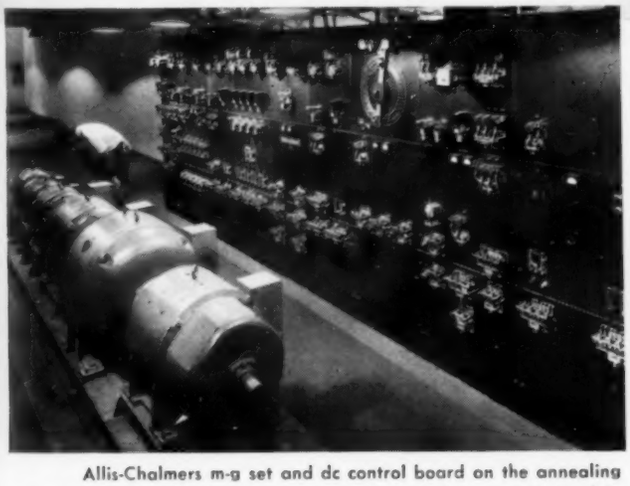




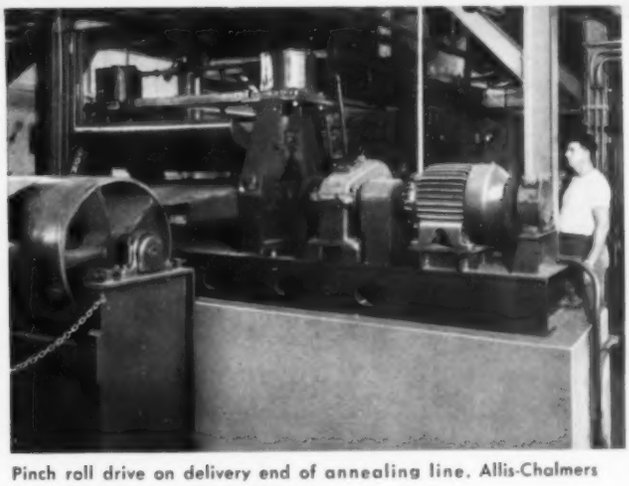
Operator's station, entry end, 36-inch hot-rolled pickling line. Allis-Chalmers control, initiated from desk, gives positive, precision control of material speed.

Allis-Chalmers dc control board and metering panels, m-g set, on delivery section of the pickling line.





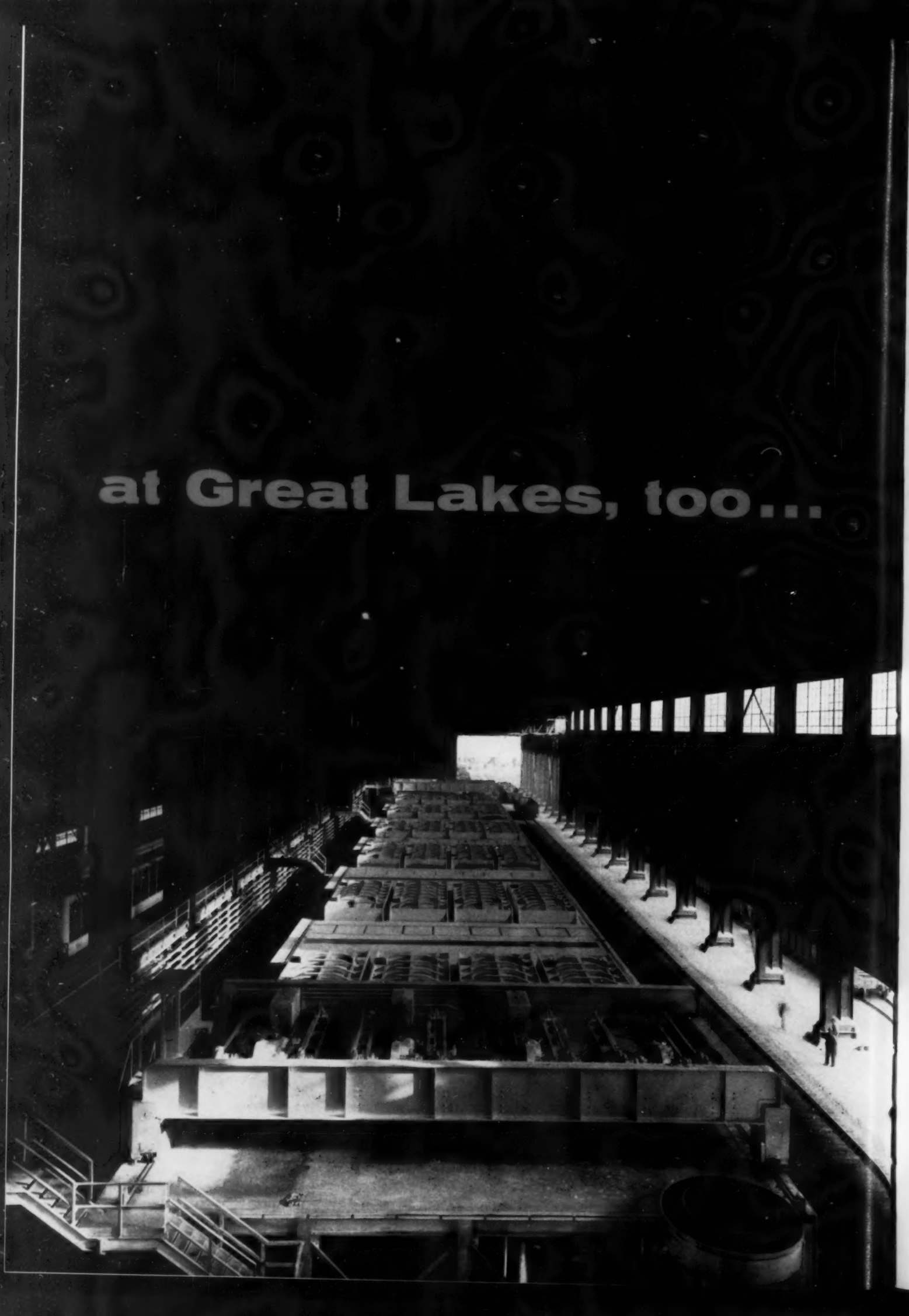
Allis-Chalmers m-g set and dc control board on the annealing line. Allis-Chalmers m-g sets and controls are recognized in the steel industry for dependable, economical service.

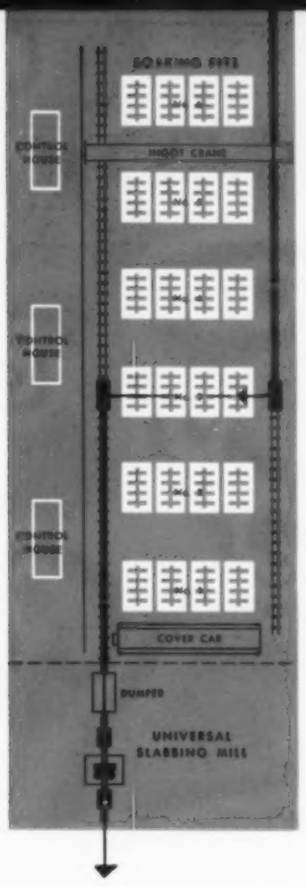


Pinch roll drive on delivery end of annealing line. Allis-Chalmers fan-cooled motors drive various parts of the processing line.

CHALMERS

at Great Lakes, too...





high-production soaking pits

. . . a convincing example of 'Surface' leadership. Behind the story of these 24 soaking pits at Great Lakes Steel, Detroit Division of National Steel Corporation, is an imposing record of achievement: Surface Combustion has built 80% of all new pits since World War II.

At Great Lakes, six batteries, four 'Surface' pits in each, heat low carbon steel ingots for automotive and appliance steel. They also heat some low alloy steel ("NAX" grade). Capacity will be still further increased by the addition of 16 new single 'Surface' pits now being built.

These one-way-fired pits include such 'Surface' features as the efficient jet pump recuperative system, and integrated temperature and combustion controls which are of the most modern design. The performance of these pits, and many others, is among the reasons why steelmakers depend on 'Surface.'

SURFACE COMBUSTION CORPORATION, TOLEDO, OHIO

Surface
STEEL MILL FURNACES

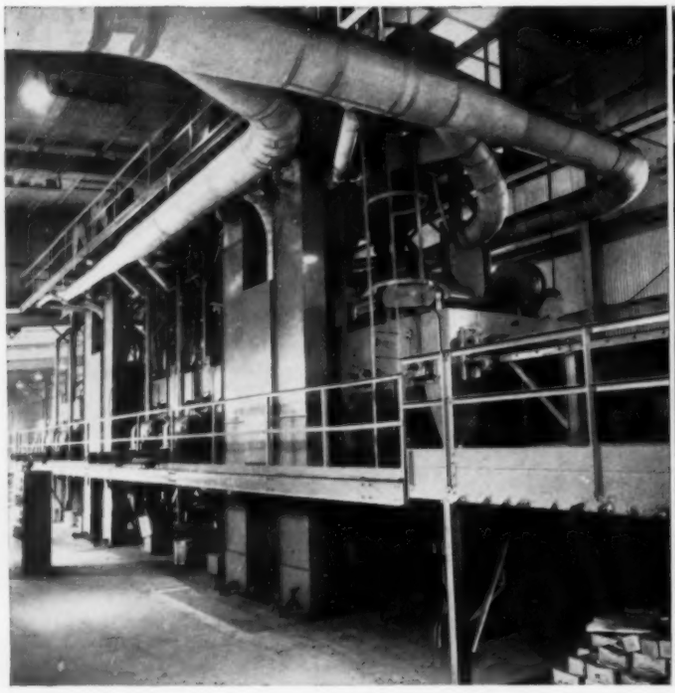
Foreign affiliate companies:

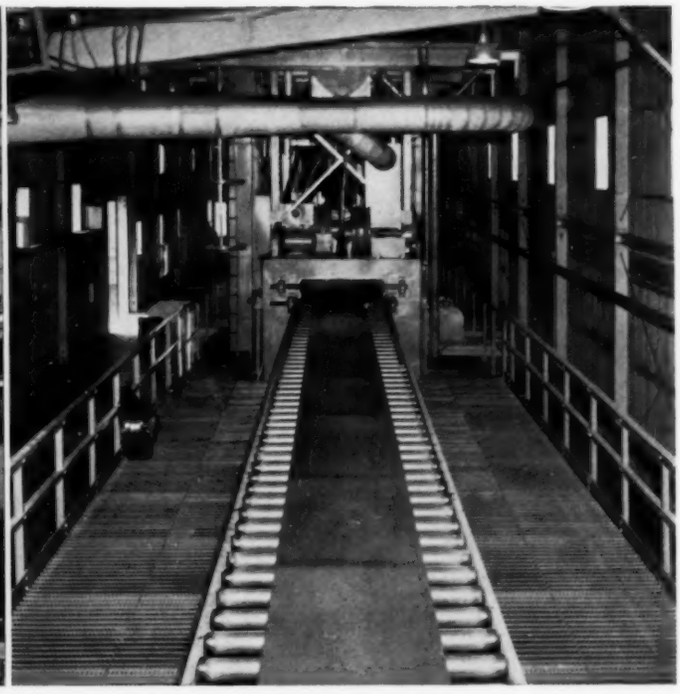
British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London

Stein & Roubaix, Paris, Liege, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka

Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

EMPIRE STEEL'S NEW CARBON STRIP LINE





CARBON STEEL STRIP MECHANICALLY CLEANED FOR THE FIRST TIME...

in the world's largest mechanical descaler

The first application of mechanical blast descaling to carbon steel strip in a producing mill has brought significant savings in time, space and expense.

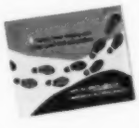
A 16-wheel Wheelabrator cabinet installed at Empire Steel Corporation in Mansfield, Ohio, cleans 250′ to 300′ of carbon strip a minute and has eliminated all pickling except a 10 to 13-second immersion in a flash-pickle tank only 60′ long.

The Wheelabrator is 66′ long and accomplishes cleaning that would require approximately 250′ of tanks for straight pickling. In addition to saving space, the blast descaling equipment has speeded cleaning and eliminated at least 75% of the acid required. This serves to reduce acid disposal problems and tank maintenance requirements.

Cold mill operators report the matte finish imparted by Wheelabrating also enhances the cold working properties of the metal.

Wheelabrator blast descaling equipment, which can be designed to handle strip at rates up to 600′ a minute, is the answer to faster production for new or existing lines. In the latter, Wheelabrator blast descaling gives increased cleaning production without requiring additional floor space.

For more information on Wheelabrator blast descaling principles and savings, send today for Bulletin 864.



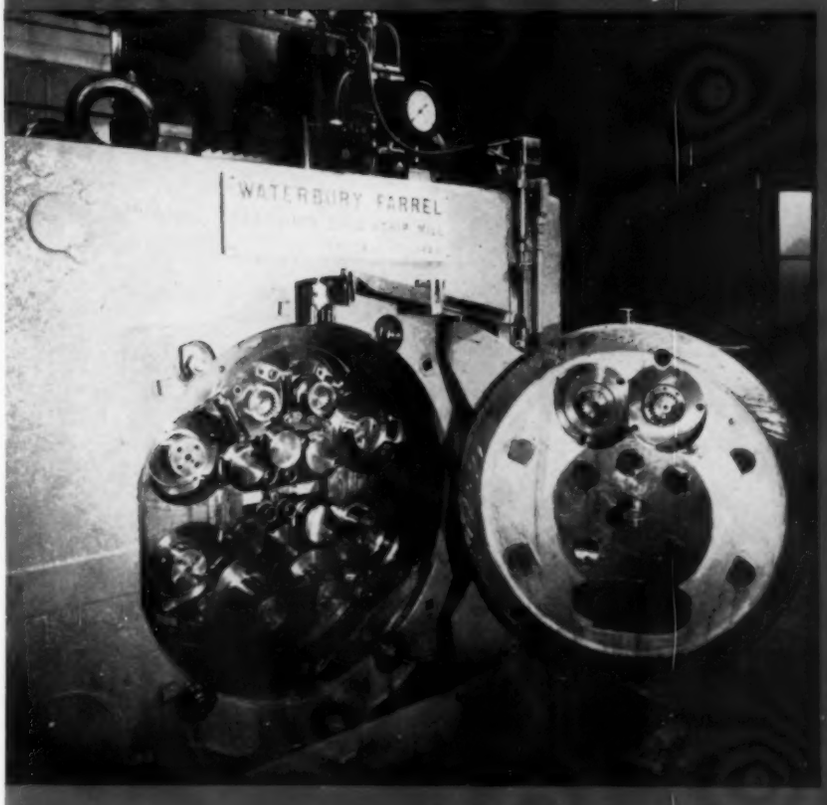
WHEELABRATOR
CORPORATION
(Formerly American Wheelabrator & Equipment Corp.)

396 S. Bykrit Street, Mishawaka, Indiana

Trail Blazer of Industrial Progress

FACTS

about a bearing installation from Bearings, Inc.



FACT—This cold strip mill performs a 70% reduction on light gauge silicon steel. The bearings needed for this job must carry heavy loads. Yet, they must be precise to help insure continuous production of strip without gauge variation from end to end of coil.

FACT—A Bearings, Inc. engineer, working with the manufacturer, insures bearings of the proper type and fit for the application. The wide experience of our bearing engineers plus the many bearing types we distribute guarantee that the bearings we recommend and supply are the best for your needs—ones which will give you long trouble-free SERVICE.

FACT—When the O.D. of these bearings become indented by fragments or roll flattened from extended service, we can have them ground by the manufacturer in shafts sets to +.0002" section height. In this way we help you get greatly increased mileage from your bearings. Isn't this the bearing service you expect from your authorized bearing distributor?

Bearings, Inc.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Springfield • Toledo • Youngstown • Zanesville

INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute

PENNSYLVANIA: Erie • Harrisburg • Philadelphia • Pittsburgh • York

WEST VIRGINIA: Charleston • Huntington • Wheeling

NEW JERSEY: Camden

Subsidiary: Kentucky Ball and Roller Bearing Co. • Louisville, Ky.

Bearings, Inc., 3634 Euclid Avenue
Cleveland 15, Ohio

Gentlemen:

☐ We have a bearing problem we would like to dicuss with a Bearing Engineer.

☐ Please send us complete information on your grinding service.

Name .....

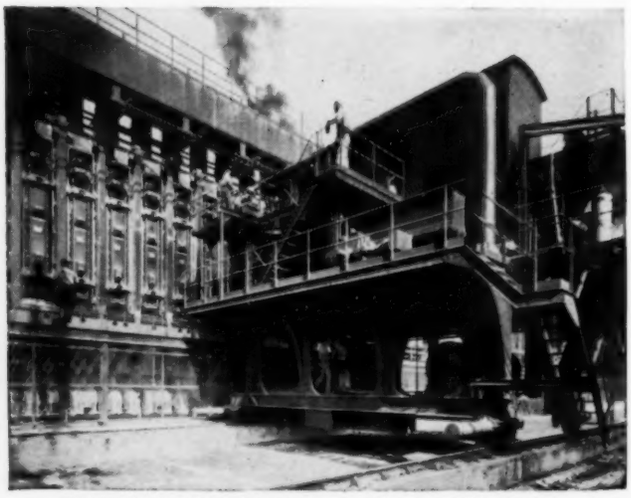
Firm .....

Address .....

City ..... Zone ..... State .....

Installation photos — courtesy of Jones & Laughlin Steel Corporation.

With minimum maintenance, EC&M LINE-ARC Contactor Control has operated this Ore Bridge for several years.



EC&M TIME-CURRENT Control excels for Coke Pushers, Door Machines and Larry Cars.

PREFER EC&M

Industry production rates are higher today than ever before. Men and machinery are being put to severe tests. Because of this, men in command are relying on EC&M control for the BIG jobs in steel.

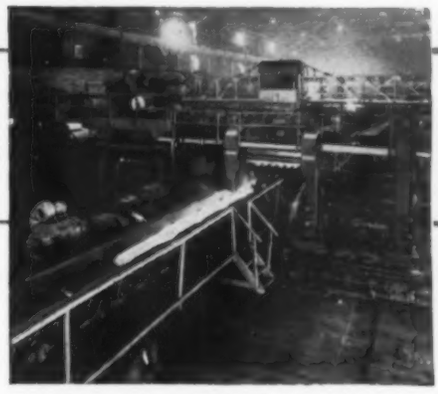
EC&M is prepared to engineer control equipment for your cranes, mill drives and other production operations . . . control equipment that will minimize down time . . . equipment that will guarantee you dependable and precision performance. When planning expansion or modernization programs, specify EC&M equipment.

THE ELECTRIC CONTROLLER & MFG. CO.

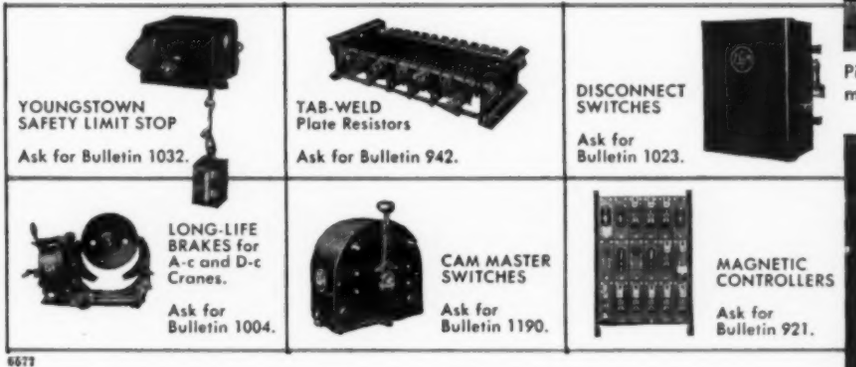
4498 Lee Road • Cleveland 28, Ohio

On. B.F. Skip Hoists, EC&M Control gives high output with maximum dependability.

Pit Crane, EC&M Controlled, keeps blooming mill supplied for top capacity.



Traveling Tilting Tables with EC&M TIME-CURRENT Control.

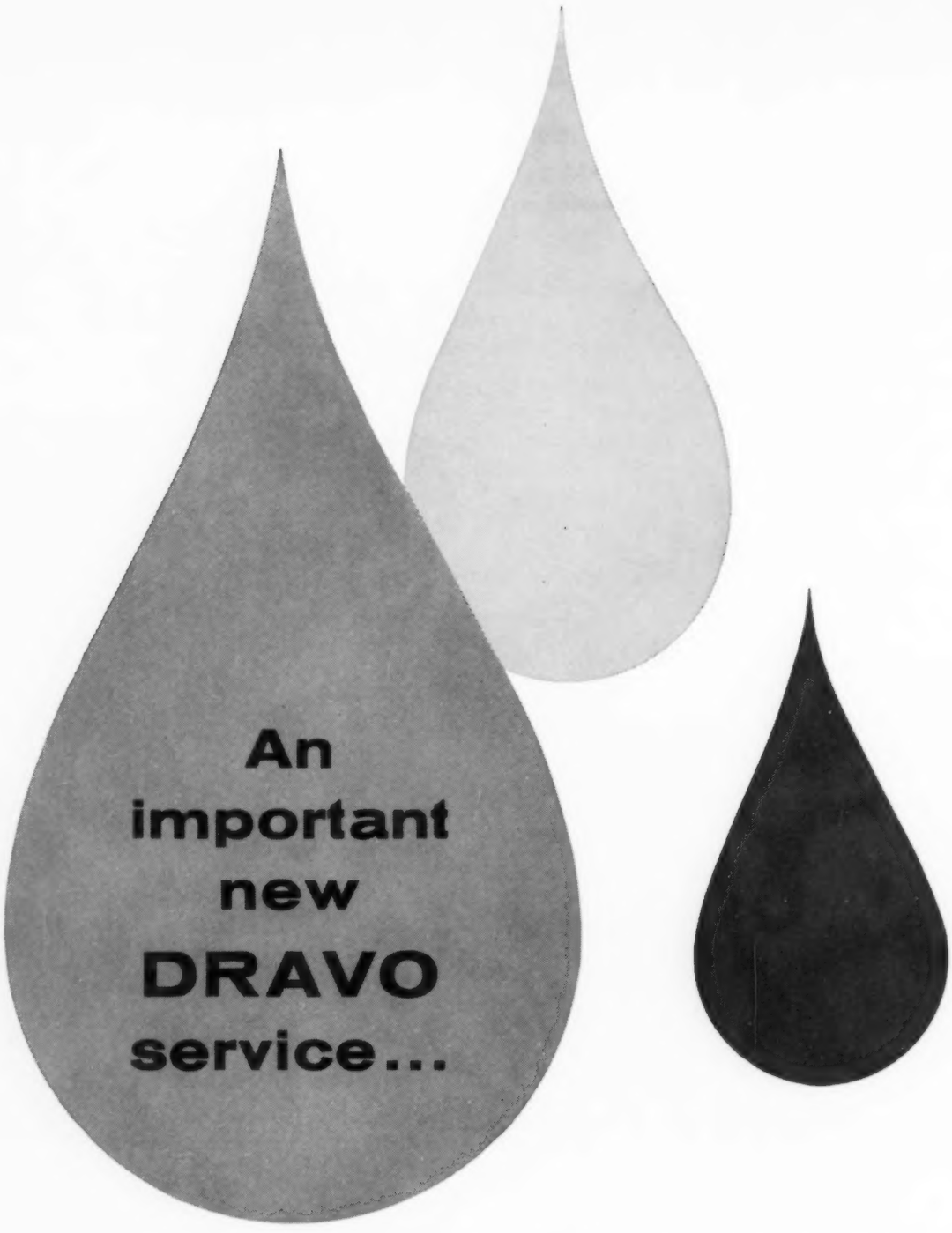


6677

BIG JOBS IN STEEL

Crane over Blooming Mill uses EC&M Wright Lowering Circuit . . . famed for safety and simplicity.

EC&M Control provides greater safety for Hot Metal and Ladle Cranes . . . and Charging Machines.



For a new concept in design, engineering and installation of specialized mill lubrication systems, you are invited to call upon Dravo's new Lubrication Section. This new service has been made possible by our recent acquisition of The DeLaval Separator Company's Mill Lubrication Department with its experienced engineering staff. Now Dravo will be able to offer industry another fully engineered service based upon a thorough knowledge of customer requirements. For complete details, write Dravo Corporation, Industrial Department, Dravo Building, Fifth and Liberty Avenues, Pittsburgh 22, Pennsylvania.

DRAVO

DRAVO-DE LAVAL OIL SYSTEMS

Special Lubrication and Coolant Systems for mechanical equipment serving industry

Crops *and* Shorts

EXCEPT for the fact that the meetings were conducted principally in Spanish, the First National Congress of the Mexican Iron and Steel Industry might well have been an AISE meeting in different surroundings. Held in the Casino in Monterrey, October 23-26, the program included simultaneous sessions on various subjects, including raw materials, economics of the industry, modernization of plants, methods of increasing production, exportation and importation of iron and steel, industrial relations, etc. Several general sessions were also scheduled.

Several of the papers were presented by representatives of producers of equipment and supplies in the United States.

The program also included visits to four plants (Hojalata y Lamina, S.A., Cia. Fundidora de Fierro y Acero de Monterrey, S.A., Industrias Monterrey, S.A., and Fabrica de Ladrillos Industriales y Refractarios, S.A.) in Monterrey. These plants, though relatively small, are comparable to many plants in the United States.

Hojalata y Lamina is a modern plant with electric arc furnaces, soaking pits, blooming mill, reversing hot strip mill and cold rolling and finishing facilities. This plant produces flat hot and cold rolled products. Future plans include two large electric furnaces and perhaps open hearth furnaces. Two 15,000-kw gas turbogenerators for power supply are on order.

The Fundidora plant, with two blast furnaces and five 90-ton open hearths, produces shapes, rails, tubes and wire. It is some 50 years old. The reversing blooming mill, reversing rougher and structural mill are driven by steam engines. A new bar, rod and skelp mill now under construction would excite envy in a lot of rolling mill men in the United States.

The visit to Industrias Monterrey uncovered a unique combination of enterprises, with a sheet galvanizing plant, a flour mill and a factory making shirts, underwear, etc. grouped together. Other plants of this company provide even greater diversification.

Through the courtesy of H. R. Pape, general manager of Altos Hornos de Mexico, S.A., at Monclova, some 150 miles from Monterrey, your editor was also able to visit that plant, which is little less than an industrial miracle. Here, in the middle of what seems like nowhere, is a constantly growing plant of 104 coke ovens, two blast furnaces, four 120-ton open hearths, reversing universal mill, reversing hot and cold strip mills, and finishing facilities for sheet and tin plate. A fifth open hearth furnace is under construction and a sixth is planned. Three centrifugal machines turn out cast iron pipe 3 to 14 in. in diameter.

When ground was broken in 1942, a capacity of 60,000 tons per year was planned. The plant produced 80,000 tons in its first full year of operation, and will produce 300,000 tons this year. Plans call for 400,000 tons in 1956 and 500,000 tons per year later.

A steel man from the United States might feel at home in any of the Mexican steel plants, but particularly so at Altos Hornos, where he may well encounter equipment he has previously worked with. Much used equipment was purchased in the United States and rebuilt in the complete shop facilities at Monclova. Much equipment was also built in these shops. As a result, the plant can boast an investment cost of $80 per ton of annual capacity, including the cost of mining facilities.

With an attendance of about 300, this meeting represents a first step toward cooperation which should be of great benefit to the iron and steel industry of Mexico. At present, there seems to be some jealousy in the industry and some tendency to secretiveness such as used to prevail in the United States years ago. We believe that future meetings, similar to this first one, will bring the exchange of technical information between the various companies that is so essential to real industrial progress.

We are glad to have been able to attend the meeting in Monterrey and we extend best wishes for the future of the National Chamber of the Iron and Steel Industry of Mexico.

▲

STEEL companies expect to produce approximately 112,000,000 tons of steel in 1956. And according to Sydney D. Maddock, president of C.I.T. Corp., spending for capital goods will move upward in 1956. Republic Steel's $130,000,000 expansion, Armco's $111,000,000 program, National Steel's $75,000,000 project, Wheeling Steel's $65,000,000 proposal, Jones and Laughlin's stepped up program of $250,000,000, and many more — looks like a good year ahead for everyone.

▲

THEY say the amount of sleep needed by individuals varies, except that each one needs just five minutes more.

▲

AN interesting development is the announcement that Jones and Laughlin Steel Corp. will install converters for steelmaking by the oxygen process at its Aliquippa Works. Pioneered on this continent by relatively small companies (Dominion Foundries and Steel, Ltd., and McLouth Steel Corp.), the process has apparently proved itself. Aliquippa Works, with its high ratio of iron capacity, seems well adapted for the process.

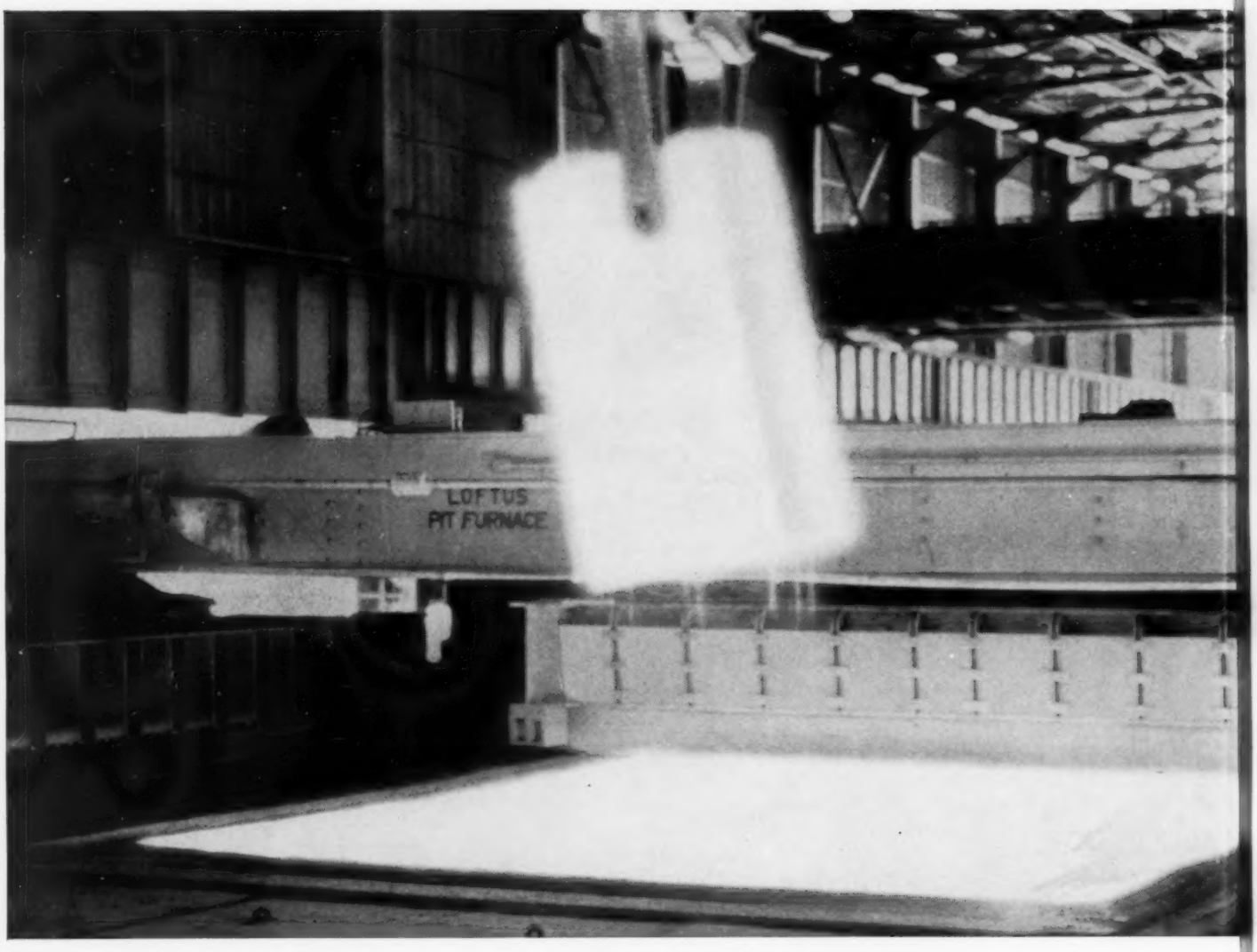
▲

EACH year about 35,000 people are killed in traffic accidents, and that's bad. A mitigating circumstance, however, is the increasing amount of automobile traffic. Over the past 20 years, traffic deaths each year have remained about the same, but the current death rate per 100,000,000 miles traveled is only about 40 per cent of the figure of 20 years ago.

▲

FROM Typographic:

A woman may be small of frame
With tiny feet that patter,
But when she puts one small foot down
Her shoe size doesn't matter.



HAGAN CONTROL &

Provide Accurate Fuel-Air Ratio Control at U. S. Steel's CLAIRTON SOAKING PITS

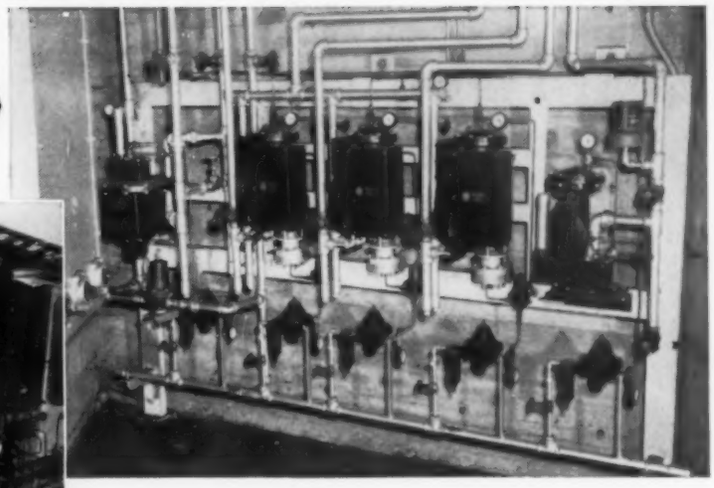
The newly rebuilt U. S. Steel Clairton soaking pits, designed by Loftus Engineering Corporation, are noteworthy for the comparatively short track time involved, the use of non-luminous flame (requiring higher air pressure), and the fact that they are used for treating a wide variety of steels.

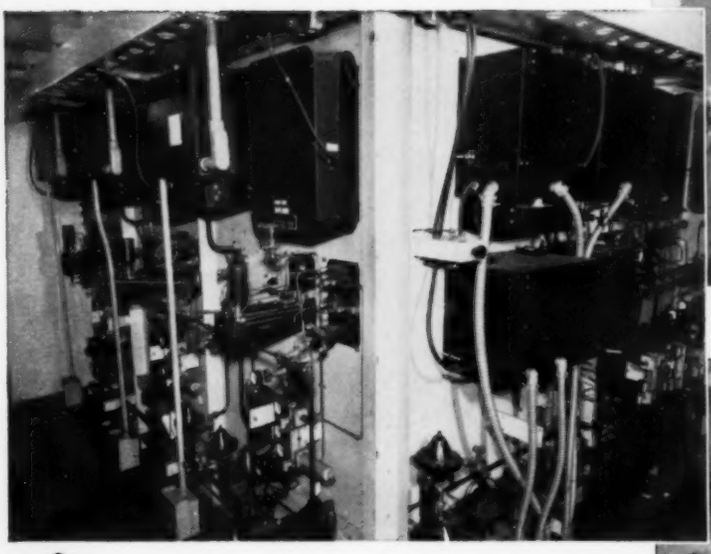
All of these factors demand accuracy and dependability in the control system. The Hagan systems now in use at Clairton provide more than the required precision, reliability and speed. Since the control lines are pneumatic, good housekeeping is easy, and safety is insured.

In addition to fuel-air ratio, the Clairton pits have Hagan control and metering of gas pressure, fan pressure, recuperator temperature and flue pressure. Hagan pneumatic systems are simple, direct-acting and are built to endure the most severe operating conditions.

Hagan's wide experience with automatic controls for soaking pits, blast furnaces, open hearths and heating furnaces is at your disposal. Call your nearest Hagan representative when you have a problem.

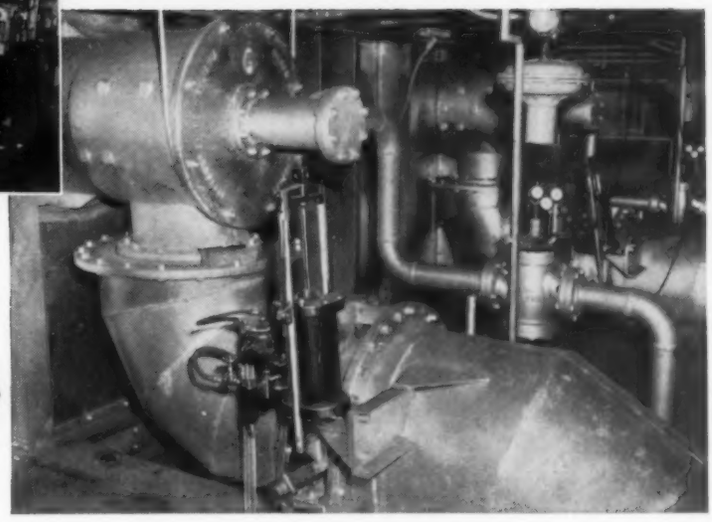
FLUE DRAFT, AIR FLOW AND COMBUSTION AIR TRANSMITTERS
Note simplicity of installation.





REAR OF CONTROL PANEL
Note accessibility.

PIT AIR DAMPER POWER UNIT
Precision positioning regulator—repeatability 0.5%.



INSTRUMENTATION

FUEL-AIR RATIO CONTROL regulates combustion air flow in proportion to gas flow to each pit. Automatic compensation is made for temperature variations of heated air. Gas and air flows are recorded, and gas flows integrated on Hagan Ring Balance Meters. Air-to-gas ratio is manually adjustable at the control panel.

PRESSURE CONTROLS consist of independent systems for the control of:

- Main line gas pressure for both rows of pits.
- Forced draft outlet pressure to each row.
- Pit pressure by positioning of stack dampers.

Interlocks cut off air and gas flow, and move stack damper to a pre-determined safe position when pit cover is lifted.

RECUPERATOR is protected against overheating at low flows by temperature control. Excess heated air is automatically bled off to atmosphere.

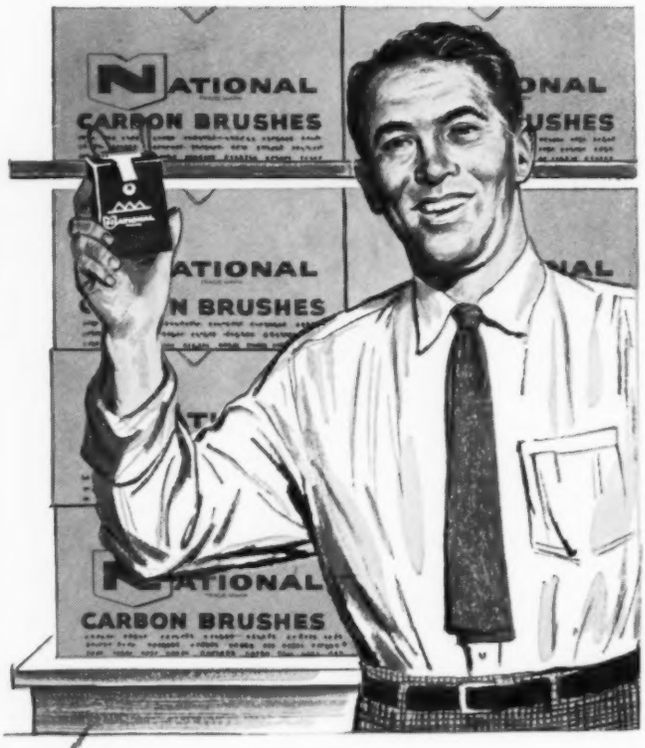
These Hagan Automatic Control Systems maintain operating conditions in the pits at high efficiency, so that production can be held to maximum levels with minimum scaling of ingots. Safety and cleanliness are assured with Hagan *pneumatic* controls.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

Metallurgical Furnace Control Systems • Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Control Systems for Aeronautical and Automotive Testing Facilities



BEST BRUSH... BEST BRUSH LINE...

NATIONAL BRUSHES
TRADE-MARK

Your best bet, *from individual application to your entire mine or mill requirement,* is "National" brushes... best because they give you maximum machine efficiency at minimum brush cost.

Here's why:

PROVED GRADES

Grades to suit every operating condition... widest selection in the industry.

RESEARCH AND DEVELOPMENT PROGRAM

Active, sustained program assures new brushes for new-design machines; continually improved brushes for existing machines.

TECHNICAL SERVICE

Helps you get best electrical performance and reduce maintenance costs... streamlines brush-buying practice.

Start saving brush dollars now in operation, ordering and handling... Specify "National" brushes and be confident of top performance throughout your mine or mill.

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd St., New York 17, New York

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco
IN CANADA: Union Carbide Canada Limited, Toronto

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
W. C. FRIESEL, *Advertising Manager*
T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
JOHN H. VOHR
General Superintendent
United States Steel Corp.
Gary Steel Works
Gary, Ind.

FIRST VICE PRESIDENT, W. H. COLLISON, *Plant Superintendent,* Blast Furnaces and Coke Works, Great Lakes Steel Corp., Ecorse, Mich.

SECOND VICE PRESIDENT, J. D. O'ROARK, *Assistant Manager, Department of Service and Maintenance, Electric,* Weirton Steel Co., Weirton, W. Va.

TREASURER, LEONARD LARSON, *Chief Engineer,* Republic Steel Corp., Cleveland, Ohio.

SECRETARY, EMIL KERN, *Vice President in Charge of Engineering,* Allegheny Ludlum Steel Corp., Brackenridge, Pa.

PAST PRESIDENTS: J. L. YOUNG, *Vice President, Engineering,* United States Steel Corp., Pittsburgh, Pa.

E. L. ANDERSON, *Superintendent, Electrical Department,* Bethlehem Steel Co., Johnstown, Pa.

HONORARY DIRECTORS: JAMES FARRINGTON, Steubenville, Ohio.

L. F. COFFIN, *Assistant General Manager,* Bethlehem Steel Co., Sparrows Point, Md.

DIRECTOR-AT-LARGE: S. C. READ, *Director, Construction and Maintenance,* Jones & Laughlin Steel Corp., Pittsburgh, Pa.

DIRECTORS: G. J. GOCKSTETTER, *Chief Combustion Engineer,* Republic Steel Corp., Chicago, Ill.

T. M. FAIRCHILD, *Assistant to General Manager,* Bethlehem Steel Co., Johnstown, Pa.

A. M. CAMERON, *Superintendent, Rolling Mill,* Atlas Steels Limited, Welland, Ontario, Canada.

D. E. WHITEHEAD, *General Lubrication Engineer,* Crucible Steel Co. of America, Pittsburgh, Pa.

H. L. JENTER, *Manager of Operations, Cleveland District,* American Steel & Wire Division, United States Steel Corp., Cleveland, Ohio.

PAUL E. LINDBERG, JR., *Superintendent of the Hot Metal Division,* McLouth Steel Corp., Trenton, Mich.

JOHN A. FERGUSON, *Electrical Engineer,* Republic Steel Corp., Youngstown District, Youngstown, Ohio.

E. C. HITE, *Assistant Superintendent of Maintenance,* Timken Roller Bearing Co., Steel and Tube Division, Canton, Ohio.

C. G. HOGBERG, *Assistant to Vice President,* Michigan Limestone Division, United States Steel Corp., Detroit, Michigan.

E. F. DONATIC, *Assistant General Superintendent, Service Division,* Kaiser Steel Corp., Fontana, Calif.

C. S. CASSELS, *Chief Project Engineer,* Henry Disston & Sons, Inc., Philadelphia, Pa.

C. L. SQUIER, *Assistant to Superintendent, Electrical Department,* Bethlehem Steel Co., Lackawanna, N. Y.

L. A. TERRY, *Superintendent, Power and Electric Department,* National Tube Division, United States Steel Corp., Gary, Ind.

K. R. DANIEL, *Vice President and Chief Engineer,* American Cast Iron Pipe Co., Birmingham, Ala.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pa.

Iron and Steel ENGINEER

NOVEMBER, 1955 VOLUME XXXII NUMBER XI

In This Issue

Patent Reviews — By Melvin Nord, Patent Attorney, Detroit, Mich..... 23
Crops and Shorts..... 51
Pinholes in Thin Steel and Pinhole Detecting Apparatus — By George H. Rendel, Research Associate, Research and Development Laboratory, United States Steel Corp., Pittsburgh, Pa..... 57
An X-Ray Tin Thickness Gage for the Electrolytic Tin Line — By R. R. Webster, Assistant Manager, Metallurgical Research, Jones and Laughlin Steel Corp., Pittsburgh, Pa..... 65
Jones & Laughlin . . . Aliquippa Works — By T. J. Ess..... 73
Roll Neck Lubrication — By Herman C. Inlow, Research Chemist, Cities Service Research and Development Co., East Chicago, Ind..... 104
Modernization of 84-In. Plate Mill at Alan Wood Steel Co. — By Thomas H. Williams, Assistant Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa..... 110
Application of Rotary Hearth Furnace for Heating Plate Mill Slabs — By F. C. Schoen, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa... 116
Reel Control Systems for Mills and Process Lines — By A. J. Winchester, Jr., Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa..... 125
Methods of Increasing Open Hearth Production — By G. W. Teskey, Open Hearth Superintendent and W. L. Murphy, Fuel Engineer, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif..... 135
Current AISE District Section Meeting Notices..... 139
Ventilation of Steel Mill Equipment — By S. L. Jameson, Construction Engineering Section, General Electric Co., Schenectady, N. Y..... 140
Modern Coal Mining — Underground — By R. H. Knapp, Chief Engineer — Coal, Central Operations, United States Steel Corp., Pittsburgh, Pa. 153
Gear Type Couplings Give Trouble-Free Service..... 158
Equipment Builder Unveils Expansion Program..... 161
Kaiser Aluminum to Expand Manufacturing Facilities..... 161
J & L Announces Major Additions to Expansion Program..... 168
J & L Dedicates New Research Laboratory..... 171
Inland Steel Announces Major Additions to Expansion Program..... 172
Date-line Diary..... 183
Industry News..... 195
Personnel News..... 219
Publication Service..... 243
Equipment News..... 253
Book Reviews..... 266
Index to Advertisers..... 277

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1955, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds)..... $ 7.50 per year
Subscription price in foreign countries (U. S. funds)..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1970285 LICENSE NO. 120

Because the furnace sets the pace,

Lectromelt* Furnace Equipment

is popular in plants all over the world

THE furnace department establishes the rate at which the rest of the plant works. Production of every department that follows is limited to what the furnace produces. Dependability is a prime requirement for the furnace equipment, therefore, and there must be a minimum of downtime for repairs.

Lectromelt Furnaces are sturdy, able to work week after week at top production. They can be readily adapted to variations in processes, to keep step with process developments. Dependability and versatility demonstrated by Lectromelt Furnaces throughout the past forty years account for their use all over the world.

Catalog No. 9-A describes the various types of melting and refining furnaces. For a copy, write Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

Manufactured in... GERMANY: Friedrich Kocks GMBH, Dusseldorf... ENGLAND: Birlec, Ltd., Birmingham ... FRANCE: Stein et Roubaix, Paris... BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege... SPAIN: General Electrica Espanola, Bilbao... ITALY: Forni Stein, Genoa ... JAPAN: Daido Steel Co., Ltd., Nagoya

*REG. T. M. U. S. PAT. OFF

MOORE RAPID

WHEN YOU MELT... *Lectromelt*

Pinholes in thin Steel and Pinhole Detecting Apparatus

By GEORGE H. RENDEL
Research Associate
Research and Development Laboratory
United States Steel Corp.
Pittsburgh, Pa.

. . . . much progress has been made in the development of pinhole detectors . . . . nevertheless, unless maintenance is kept at a very high level, performance of late models will be no better than that of the earlier units . . . . however, since some perforations will escape detection, every effort must still be made to minimize causes of holes . . . .

▲ IN the process of converting steel ingots to finished steel of thin gages, there occur small perforations normally referred to as pinholes. It is common practice to use the term "pinhole" very vaguely. In fact, perforations of various sizes, from holes 0.0005 in. in diameter to a sliver many feet in length, may be classed as pinholes.

CAUSES AND TYPES OF PERFORATIONS

Pinholes in the base metal are caused by a number of conditions, which may be grouped in two general classes.

Class 1 includes conditions related to steel quality, such as slivers, laminations, pipe, and inclusions.

Class 2 includes conditions related to mechanical causes, such as rolled-in particles, spall marks, cracked edges, gouges, deep scratches, rolled-in scale, and pop-outs.

In general, experience has indicated that pinholes resulting from mechanical causes far outnumber those resulting from steel quality, although the ratio may vary from plant to plant. It has been found difficult to diagnose accurately the cause of many types of perforations by observing the finished product, unless the progress during the several stages of processing has been studied. Many defects that ultimately cause pinholes do not appear as perforations until the material is rolled to a thickness of less than about 0.020 in. It is generally recognized that the frequency of perforations increases as the sheet is reduced to the thinner gages. Experience also indicates that pits and deep scratches are responsible for many potential holes which frequently develop into perforations during the manufacture of the cans or containers.

Figure 1 shows the outline of a relatively common type of pinhole that occurs in thin strip or sheets. This

Figure 1 — Outline shows a pinhole about 0.0003 x 0.0025 in. which was caused probably by a gouge prior to cold reduction.

perforation was in a sheet about 0.010-in. thick and had a vertical projected area of about 0.0000007 sq in., which is equivalent to that of a round hole about 0.001 in. in diameter; it was apparently caused by a gouge on the strip prior to cold reduction. Although this perforation is considered relatively "large," in one direction it would be difficult to detect visually except for the customary surface flaw that is normally present adjacent to a perforation.

Many holes occur at oblique angles through the sheet. As indicated in Figure 2, an angular hole may not appear as a hole but rather as a surface defect or a pit unless viewed at the correct angle. For instance, as shown in Figure 2A, the perforation had no visible perforated area when viewed at 90 degrees from the strip surface; Figure 2B shows the outline of this perforation as viewed at 60 degrees from the strip surface; Figure 2C shows the outline of the same perforation as viewed at 45 degrees from the strip surface. On this perforation, more light rays were transmitted through the perforation at 60 degrees than at 45 degrees from the strip surface.

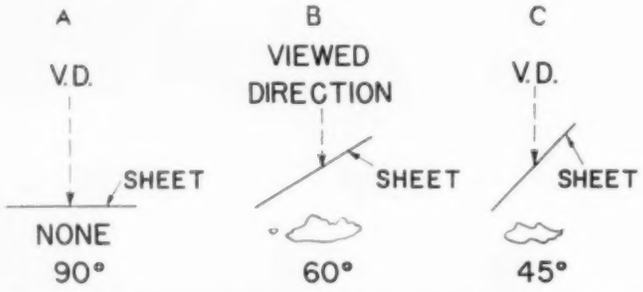


Figure 2 — Projected outlines show angular perforations at several angles from the surface of the sheet.

Because the principal rays from the pinhole detector light source are transmitted at 90 degrees from the strip surface, the detection of an angular hole depends on the relatively small amount of angular light rays and/or reflected light from the sides of the hole.

NEED FOR PINHOLE DETECTORS

The need for an automatic pinhole detector had been recognized, but it did not appear feasible or absolutely necessary prior to the transition from hand hot finishing mills to cold-reduction finishing mills. The finished product from the hand hot mills was in sheet form in various lengths up to a maximum of about 8 ft. Also, on the hand hot mills, most perforations appeared to be sticker holes caused by forcibly separating the sheets after pack rolling. Because the product from cold-reduction mills was in strip form and several thousand feet long, and because perforations occurred more frequently on cold-reduced product than on hot-rolled product, it appeared practical to pass the elongated, cold-reduced coiled sheets through pinhole detectors in an attempt to prevent shipment of perforated sheets to the customers.

DESIGN AND FUNCTIONS OF PINHOLE DETECTORS

From the beginning, it appeared that a pinhole detector should be a photoelectric apparatus which would irradiate one side of the strip and would use a photosensitive device on the other side. It also appeared necessary that suitable shields be provided to exclude all light from the photosensitive device except the light passing through the perforations in the strip.

Expect for a number of optical refinements and significant improvements in electronic circuits, the earliest pinhole detectors were similar to some of those currently furnished to the industry. Briefly, an electronic pinhole detector consists of a suitable light source; a number of photosensitive tubes installed in an enclosed light-proof scanner; and an electronic amplifier and associated control devices, which may be designed to mark the strip adjacent to the perforation and/or to divert the section of perforated strip after it has been sheared to the desired length.

Electronic pinhole detectors are actuated by an electrical signal or impulse from the phototubes, the impulse being caused by rays received from the light source. The signal received from the phototubes is influenced by the diameter of the hole and the speed of the perforation as it passes the detector. In other words, the amplitude of the signal is affected by the quantity of light rays and by the rate of change of light on the electrodes of the phototubes. Signals from the phototubes may vary from about 0.1 to 1.0 millivolt depending on hole size and strip speed.

The small initial electrical signal caused by the passage of a perforation through the detector must be amplified many times to obtain a signal of sufficient magnitude to provide reliable operation of the control apparatus. On some of the early style detectors, the electrical signal from the phototubes was amplified about 250,000 times in the electronic amplifiers of the detectors. Most of the later model detectors utilized optical improvements to obtain a relatively large electrical signal from the phototubes, and thus eliminated the need for the extremely high-gain electronic amplifiers. High-gain electronic amplifiers on pinhole detectors require extremely effective filter circuits, electrical shielding, and mechanical damping to maintain the desired low noise level necessary for efficient operation.

The term noise level refers to the erratic and sometimes intermittent electrical signal received from the detector because of electrical or mechanical interference or disturbance. High noise level causes the detector to operate erratically with the result that many nonperforated sheets may be diverted. A low signal causes the detector to miss many perforations, particularly if the perforations are small. Our experience has indicated that a consistent signal-to-noise ratio of at least 5 to 1 is about the minimum value for satisfactory operation.

Several of the most recent pinhole detectors use multiple-stage photoelectric tubes. These are called photomultiplier tubes and have a built-in amplification of 100,000 to 2,000,000 within the photomultiplier tubes.

The photomultiplier tubes are more sensitive to fatigue and temperature than are phototubes, but the multiple-stage photomultiplier tubes have the advantage of providing very high amplification within the tubes. The elements of a photomultiplier tube and a conventional phototube are shown in Figure 3. A photomultiplier tube is essentially a vacuum-type emission cell with a built-in amplifier; the electrons emitted from the illuminated cathode being amplified by "secondary emission." Because the photocurrent produced at the light-sensitive cathode is multiplied many times

by secondary emission occurring at successive dynodes, the photomultiplier tube is capable of amplifying the feeble currents produced under weak illumination about 2,000,000 times when operated at about 100 volts per stage. The resultant output current from the anode is a linear function of exciting illumination under normal conditions.

Because previous uses of electronic apparatus in steel mills were very rare, the early pinhole detectors installed in 1937 were looked upon with considerable apprehension. The cathode-ray oscilloscope, the electronic voltmeter, and other instruments that have proved so essential in the maintenance of electronic

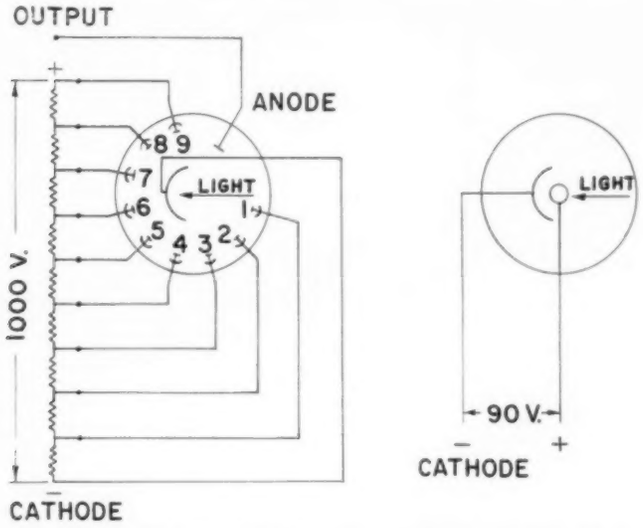


Figure 3 — Photomultiplier tube is shown on the left and conventional phototube is shown on right.

apparatus were not available in steel plants until several years after pinhole detectors were placed in service.

The operating experience gained from pinhole detectors, together with the necessity of training electronic technicians to service the detectors, was probably the largest single factor contributing to the development and extensive use of electronic apparatus in the steel industry.

EARLY TYPES OF PINHOLE DETECTORS

One early type of detector, installed in 1937, employed only nine phototubes in the scanner. These phototubes had an active electrode length of about six inches. To insure that the light transmitted through a perforation in the strip would reach an active area of at least one photosensitive electrode in the scanner, the phototubes were mounted in a skewed arrangement.

As would be expected, these phototubes were very sensitive to vibration. In fact on the 1937 installation, the vibration received from an air horn in the vicinity caused electrical disturbances of sufficient magnitude to result in false operations of the detector each time the horn blew. Operating experience soon demonstrated the necessity of substituting regular short-length phototubes for the long-element phototubes. It also was soon demonstrated that many operating delays could be avoided if all electronic equipment in the

Figure 4 — The 1938 model pinhole detector shown was installed on a black plate shearing line.

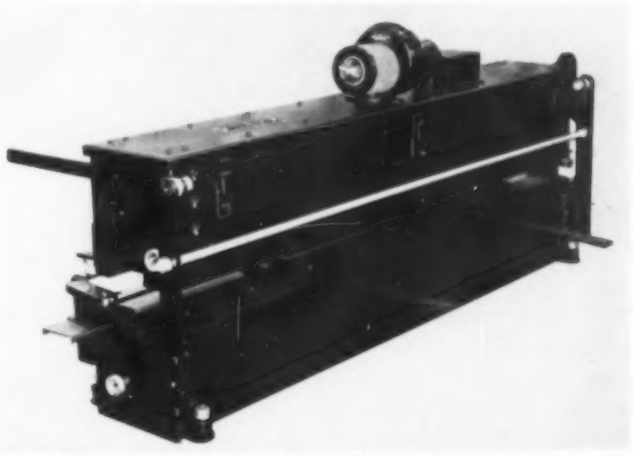


Figure 5 — This detector uses 20 prefocussed lamps for the light source and 20 phototubes in the scanner.

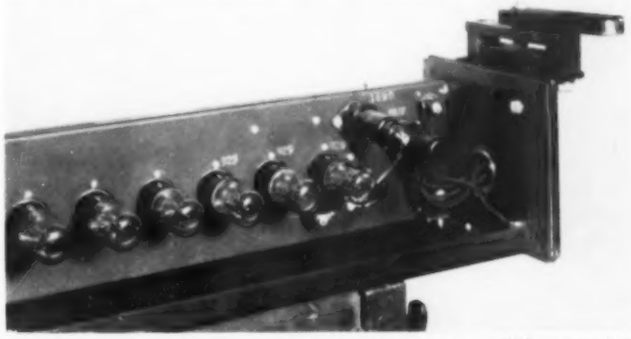


Figure 6 — Arrangement of phototubes in 1938 model is shown here. With this arrangement, light has to fall directly on the light-sensitive electrodes.

scanner could be mounted on a retractable tray to facilitate removal when trouble developed, and to permit replacement with a spare tray that had been pretested in the maintenance shop.

Figure 4 shows a commercial installation of a 1938 model pinhole detector on a black-plate side-trimming and shearing line. This detector had a rated detectable-hole size of 0.015-in. diameter at operating speeds between 80 and 1000 fpm. The illumination for this detector was provided from two 750-watt incandescent lamps; each lamp was mounted in a reflector. The hinged sheet-metal guard shown on the side of the light source could be lifted to permit servicing of the lamps

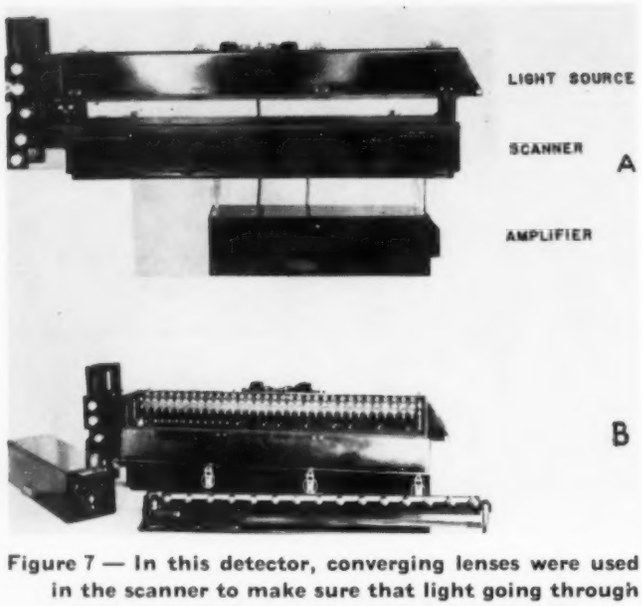


Figure 7 — In this detector, converging lenses were used in the scanner to make sure that light going through a hole would fall on at least one active electrode.

and could be lowered to protect the workmen from the glare. The deviation of light intensity across the width of the strip is not known, but it was probably very irregular.

1938 MODEL

In 1938 the pinhole detector shown in Figure 5 was made available. This detector used 20 prefocussed incandescent lamps in the light source and 20 phototubes in the scanner. Plain diffusing lenses were used in the light source and special converging lenses were provided in the scanner to collect and divert light rays to the phototubes. As indicated in Figure 6, there were no light-reflecting components in the scanner. Consequently, to be effective, light from the passage of perforations had to fall directly on the light-sensitive electrodes. Illumination at the strip-pass line was about 300 foot candles and the detector was rated to detect 0.015-in. diameter holes at strip speeds between 50 and 900 fpm. This detector had a signal-to-noise ratio of about 30 to 1 for a 0.015-in. diameter hole when the strip was operating at 300 fpm.

1939 MODEL

The pinhole detector shown in Figure 7A was installed about 1939 and used 33 projection-type incandescent lamps in the light source and 15 phototubes in the scanner. This detector used a plain lens in the light source and special converging lenses in the scanner to insure that the light transmitted through a perforation would fall on the active electrode of at least one phototube. This detector was rated to operate from 0.015-in. diameter holes at strip speeds between 100 and 1000 fpm. Numerous field tests indicated that this style of detector frequently would detect holes as small as 0.005 in. in diameter and when in the proper state of maintenance, it would consistently detect holes as small as about 0.008 in. in diameter.

The light intensity at the pass line is not known, but it appeared to be very uniform. Figure 7B shows the arrangement of the lamps in the light source and the phototubes on the floating mounting of the retractable tray in the scanner. The relatively large power consumption (about 1500 watts) of the lamps in the light source made it difficult to dissipate enough heat to obtain satisfactory lamp and lamp-socket life.

1946 MODEL

Outward appearance of a pinhole detector made available in 1946 was similar to the 1938 model illustrated in Figure 5. But unlike the earlier type, the 1946 model utilized a pair of full-length focusing lenses in the light source and was designed to illuminate at high intensity a narrow line across the strip. Illumination at the pass line was about 4000 foot candles and the detector was rated to detect 0.005-in. diameter-holes at strip speeds between 50 and 1000 fpm.

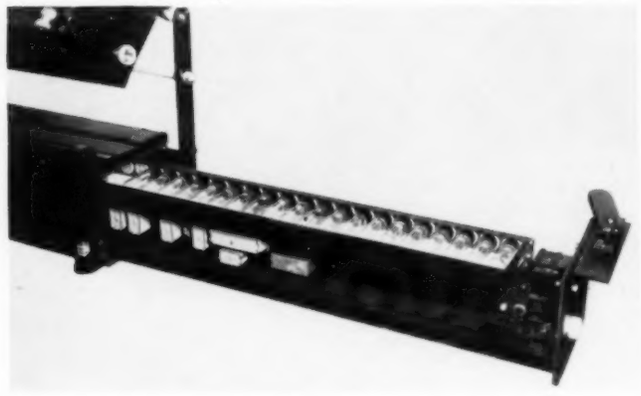
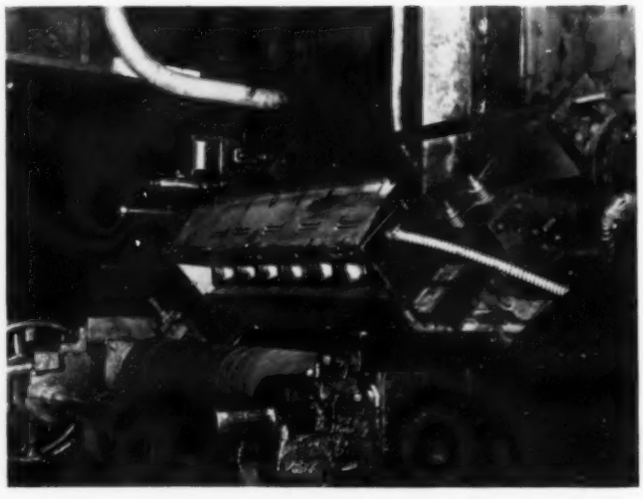


Figure 8—Phototubes are spaced very closely in this model.

As shown in Figure 8, the 31 phototubes in the 1946 model detector were spaced as closely as possible; also, a light-reflecting shield was provided directly below the phototube assembly to aid in directing light rays to the phototubes. This detector had a signal-to-noise ratio of about 60 to 1 for a 0.005-in. diameter hole when the strip was operating at 300 fpm. The optical improvements made on this detector made it possible to detect 0.005-in. diameter perforations with a medium-gain electronic amplifier of about 8000 to 1.

Figure 9 — This detector can find perforations as small as 0.007 in. in diameter on strip operating up to 2000 fpm.



1949 MODEL

A pinhole detector that was made available in 1949 is shown in Figure 9. The louvered side shield is shown in a raised position to provide a better view of the light-source interior. The scanner with its preamplifier, and the main amplifier with its controls, are not visible in the photograph. This detector uses seven 150-watt flood lamps in the light source and is designed to detect perforations as small as 0.007 in. in diameter on strip operating between 80 and 2000 fpm. With this detector, a signal-to-noise ratio of about 8 to 1 is obtained on 0.007-in. diameter porforations on strip operating at about 300 fpm. The total amplification of the preamplifier and main amplifier on this detector is adjustable between about 1,000,000 and 9,000,000.

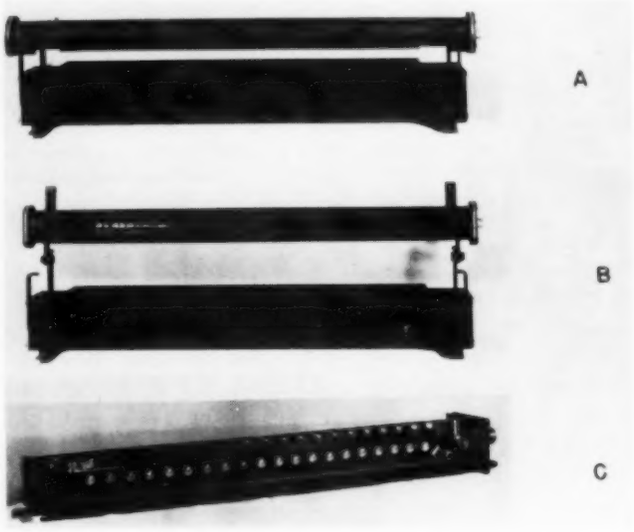
1953 ULTRAVIOLET MODEL

The ultraviolet pinhole detector was made available in 1953. This detector uses a 4000-cycle mercury-vapor light source that produces 8000 light impulses per second, and the amplifier is tuned to receive the frequency of the light impulses, 8000 cycles per second. All previous-model pinhole detectors used incandescent light and untuned amplifiers.

The ultraviolet detector utilizes a flat glass filter in the scanner designed to exclude all but about one per cent of the visible light and to pass about 85 per cent of the ultraviolet light in the wave length of about 3660 angstroms. Another departure from the former practice was the use of photomultiplier tubes in the scanner of the ultraviolet detector instead of phototubes.

Figure 10 shows several views of the ultraviolet detector. Figure 10A shows the light source and scanner in operating position without the light guides. Figure 10B shows the light source in the raised position and shows the mercury vapor lamp, reflector, and light barrier as viewed through the protective glass of the light source. Figure 10C shows the arrangement of the photomultiplier tubes and the V-shaped chrome reflector as mounted on the retractable tray of the scanner. Because the tuned amplifier of the ultraviolet detector is designed to receive 8000-cycle signals (within a tolerance of about ± 250 cycles), much of the electrical interference that caused high noise level on earlier-model detectors is 'tuned out' on the ultraviolet detector. Also, because the amplifier is tuned to receive the 8000-cycle impulses from the light source, the ultraviolet detector does not depend on the strip movement to provide a suitable rate of light change; consequently this detector will provide a full rated signal from a perforation even if it is at rest.

Figure 10 — Ultra-violet light is used in this pinhole detector.



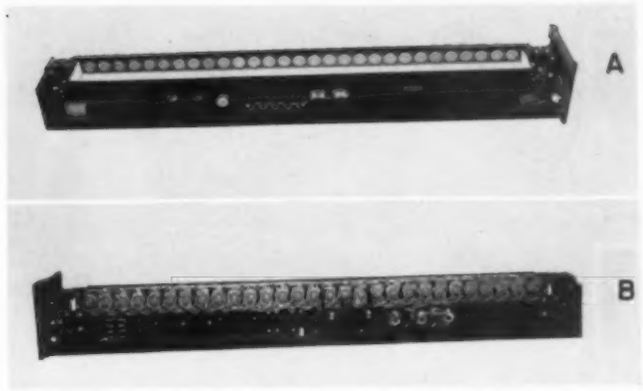


Figure 11 — Detectors can now locate holes as small as 0.001 in. in diameter.

The tuned amplifier results in a low noise level and provides a signal-to-noise ratio of about 100 to 1 for a 0.001-in. diameter hole when the strip is traveling at 300 fpm. The detector is rated to detect 0.001-in. diameter holes when the strip is at rest or traveling at speeds up to 1200 fpm. The full-length mercury-vapor lamp tube used in the light source of the ultraviolet detector provides maximum uniformity of light intensity across the entire width of the strip. Power requirement for the light source for the ultraviolet detector is about 60 watts as compared with about 500 to 1500 watts for the incandescent light sources used on other detectors. Increasing the power of the ultraviolet light source to 500 or 1000 watts would probably make this detector capable of detecting holes much smaller than 0.001 in. and also aid further in the detection of angular holes.

1954 MODEL

Another pinhole detector designed to detect perforations equivalent in size to about 0.001 in. in diameter was made available in March, 1954, and models of this detector are now being field-tested in several plants. The 1954 model also uses photomultiplier tubes and can be adapted as a conversion unit for the 1946 model described previously. Although the 1954 model uses incandescent lights and does not use a tuned amplifier, its noise level is low and the detector provides a signal-to-noise ratio of about 100 to 1 for a 0.001-in. diameter hole when the strip is traveling at about 300 fpm.

External appearance of the 1954 model is similar to the 1938 model illustrated in Figure 5. The latest detector utilizes the same light source as the 1946 model, but is rated to detect holes 0.001 in. in diameter at operating speeds between 50 and 2000 fpm. Front and rear views of the retractable photomultiplier tubes and amplifier tray are shown in Figure 11. The front view

in Figure 11A shows the photomultiplier sockets and arrangements. Figure 11B shows the wiring and connections for the photomultiplier tubes and amplifying equipment.

RECENT DEVELOPMENTS

Concurrent with the improvement of pinhole-detecting apparatus has been the development and use of auxiliary apparatus resulting in improved performance.

Analyzer for hole detectors—One such development is an analyzer designed to check the performance of the electronic components in a pinhole detector. The analyzer has a plug-in attachment that can be connected to the phototube circuit in the scanner to simulate the passage of perforations at the pinhole detector. A glow modulator tube in the analyzer is arranged to flash, at regular intervals of known duration, a light that can be varied in intensity by adjusting a calibrated dial. A photosensitive tube similar to those used in the scanner is provided in the analyzer. Light impulses from the glow modulator tube excite the photosensitive tube in the analyzer in a manner similar to the way the photosensitive tubes are excited in the scanner when perforations pass the detector. To check the performance of a detector, the inspector or service man may connect the analyzer to the scanner and increase the light intensity of the glow modulator tube by slowly rotating the calibrated dial until the detector apparatus begins to operate. The lowest point, on the calibrated dial, at which the detector will operate provides a measure of detector performance. When the dial is calibrated to indicate equivalent hole size, the analyzer can be used to check minimum detectable hole size for a pinhole detector. Although the analyzer does not check the optical system on a pinhole detector, it provides a rapid overall check on the detector circuits and indicates whether electrical or electronic components of the detector are inefficient or faulty.

High-speed controls for detectors—Another improvement made in 1948 included high-speed control circuits that permitted the detector to detect and divert sheets containing closely spaced perforations. On prior conventional control circuits, the detectors frequently failed to detect or divert some perforations when the perforations occurred at closely spaced intervals. The failure to detect closely spaced holes was caused by long time-constants in the control circuits and by the method of interlocking the control relays. On the high-speed controls, the time-constants in the circuits were reduced to a minimum practical value and the control relays were interlocked to effect diversion of perforated sheets regardless of their spacing. During a number of field tests, series of holes were drilled at 12-in. intervals in the strip on several coils, and later the strips were passed through detectors at full operating speed. On detectors that were equipped with conventional controls, about 30 to 50 per cent of the perforations were missed; but on similar detectors equipped with high- speed controls, all the perforations were detected and diverted to the salvage pile.

Sheet pinhole detector—Another recent development is a pinhole detector to operate on cut-to-length sheets. Sheet hole detectors are designed to inspect sheets for perforations as they pass from a conveyor belt through a pinhole detector prior to entering the classifying apparatus. Auxiliary phototubes are employed to deactivate the detector during periods when sheets are not passing through the detector. These auxiliary phototubes also reactivate and maintain full sensitivity of the pinhole detector when sheets are passing through the detector. The sheet hole detector may be operated up to speeds of about 180 sheets per minute or about 600 fpm. At maximum rated speed, full sensitivity of the detector is obtained on all the sheets except about ¾ in. on the leading end, and about ½-in. on the trailing end.

Single sheet classifier—On conventional pinhole-detector controls, it is customary to divert two or more prime sheets with each perforated sheet to insure diverting all the perforated sheets. During the subsequent assorting operations, required to recover the prime sheets, perforated sheets can easily escape detection and become mixed with the prime sheets. The recently developed single-sheet classifiers operate in conjunction with "1-mil" or "5-mil" pinhole detectors and make possible single-sheet diversion.

The benefits of the single-sheet classifier increase as hole-detector performance is improved. For example, our experience on a recent field test, wherein 1-mil and 5-mil pinhole detectors were in service on the same line, indicated that about 5 per cent of the perforations in sheets diverted by the 1-mil detector were too small to be detected by the 5-mil detector. With conventional pinhole-detector controls, which divert at least three sheets for each perforation, the increase of 25 per cent in the number of holes detected would substantially increase the number of prime sheets that are diverted and require reassortment. Also, because the new detectors are capable of detecting very small holes, it would be difficult, if not impossible, for the persons assorting the product to identify many of the small holes; consequently many sheets with small perforations might inadvertantly be reclassified as primes and shipped to the customer.

On installations using single-sheet classifiers, only a very few prime sheets are diverted; consequently, reassorting the diverted product is not justified.

GENERAL DISCUSSION

It is common practice to use pinhole detectors on processing lines where the product is sheared to length. Such installations permit perforated sheets to be diverted from nonperforated sheets. In some instances, pinhole detectors have been employed on installations such as electrolytic cleaning lines.

A pinhole detector on an electrolytic cleaning line serves the useful purpose of indicating and recording the number and frequency of perforations on the product. This enables spot checks to be made soon after the product is cold-reduced; and when an excessive number of perforations occurs, the cause may be traced and corrective measures applied immediately to prevent or minimize production of perforated product.

The previously accepted rule of thumb that a satisfactory pinhole detector should be capable of detecting

perforations half as large in diameter as the strip thickness has been outmoded. With the latest detectors, a relationship of detectable diameter to strip thickness of about 1 to 15 or 1 to 0 appears to be approaching a reality. Normally the new 1-mil detectors will detect holes somewhat smaller than their rated size when they are operating at maximum efficiency and are in a satisfactory state of maintenance. In fact, we frequently have observed detection of angular holes that had no visible vertical-projected area. The ability to detect angular holes depends on the angle of the hole relative to the strip surface, and the surface characteristic of the sheet adjacent to the perforation. For example, the angular perforation shown in Figure 2 was elongated in the direction of rolling and had no visible perforated area when viewed at 90 degrees from the strip surface. When passed through an ultraviolet pinhole detector, this perforation repeatedly gave a signal-to-noise ratio of 15 to 1 when it traveled in the direction of rolling, and a signal-to-noise ratio of about 25 to 1 when it traveled transversely to the direction of rolling. Because this perforation had no visible perforated area when viewed at 90 degrees from the strip surface, it is apparent that the signal received from the hole detector was the result of reflected light rays passing through the perforation. Also, because on pinhole detectors the light rays are continuous across the width of the strip and cover a relatively narrow length, it is concluded that more light will pass through a hole that is elongated or angular transversely to the direction of rolling than will pass through a perforation that is elongated or angular in the direction of rolling.

Because of the numerous variables on angular holes, it does not appear possible to rate any pinhole detector with respect to angular-hole size. The best system for detecting angular holes appears to be to irradiate the sheet at the highest practical level of intensity and to use a hole detector that is capable of detecting the smallest possible hole size.

From the earliest to the most recent models, the rated detectable-hole size has been reduced from 0.015 in. to 0.001 in. in diameter. This represents a reduction of 15 times in diameter and 225 times in area. A 0.001 in. diameter hole has an area of about 0.0000008 sq in., and at 1200 fpm, a small perforation will pass over the 0.5 in. wide scanner lens in about 0.0025 second.

To appreciate the sensitivity of a pinhole detector, try to visualize the quantity of light that can pass through a 1-mil diameter hole in 2.5 milliseconds, and recognize that this small quantity of light will cause the detector to produce an electrical signal that is about 100 times greater than the noise level. The latest pinhole detectors are ultrasensitive and quite complex electronic apparatus. They are constructed of the most rugged and dependable components consistent with the required sensitivity and accuracy, and will perform well when maintained at their maximum efficiency.

The late-model one-mil detectors are showing good performance in service, but these detectors will not operate more efficiently than the earliest models unless they are maintained properly. It should be recognized that all pinhole detectors are highly sensitive and complex electronic devices. They are similar in sensitivity and complexity to a high grade television receiver. Probably all of us have witnessed interference on television receivers when the cause was not evident, but the quality of video or audio reception suffered seriously. Similar interference on pinhole detectors may cause false operations of the detector unit, which will divert nonperforated sheets; or the interference may desensitize the detector to such a degree that it will not detect perforations. When we realize that a satisfactory pinhole detector must provide efficient, uninterrupted service for 24 hours per day and 5 or 6 days per week, one can appreciate why the equipment should incorporate the best possible design and why it deserves the best possible maintenance.

Probably the most common factors contributing to unsatisfactory performance on good pinhole detectors are vibration, dirt, and faulty shielding from other electrical apparatus or extraneous light.

Detector operations have been observed wherein the following conditions, caused by vibration, occurred within a few hours.

1. Noise level of one volt when the processing line was idle.
2. Noise level of three volts when the processing line was operating.
3. A fault caused the noise level to increase to 30 volts when the processing line was operating.

On condition (2), which is considered about normal, vibration from the processing line and electrical interference caused the noise level to raise to three volts. The cause of the high noise level noted for condition (3) was the failure of one of the 'resilient' rubber shock-mounts on the detector. This failure permitted vibrations from the processing line to be transmitted to the electronic tubes in the detector. Obviously the high noise level experienced on condition (3), if allowed to continue, would cause false operations that would result in diverting many nonperforated sheets. Subsequent replacement of the faulty shock-mount corrected the trouble and the detector was returned to service.

To obtain satisfactory shielding from stray light, the light shields in a pinhole detector preferably should be designed to maintain physical contact with the edges of the moving sheet. Any physical contact with the edges of the moving sheet adjacent to the pinhole detector may cause small particles to accumulate on the scanner lens, with the result that operating efficiency of the pinhole detector is reduced. The accumulation of dust particles may be so rapid as to require cleaning of the lens at about one hour intervals. Numerous attempts have been made to provide automatic lens cleaners, but we know of none that have proved satisfactory.

Because of the extreme sensitivity of pinhole-detector apparatus, the best possible shielding from other electrical equipment must be provided. For example, the wiring to pinhole detectors should be installed in separate conduit and should not be placed adjacent to other electric lines. Frequently it is necessary to install arc-quenching capacitors on adjacent relay contacts or equipment to prevent false operation of a pinhole detector.

The efficiency of shielding is an important factor in obtaining a high signal-to-noise ratio. For example, with the nearly perfect shielding possible during laboratory tests, maximum amplification can be used and a signal-to-noise ratio of several thousand to one may be obtained. In operations, the efficiency of the shielding decreases; consequently the amplification must be decreased to prevent false operations and as a result, the signal-to-noise ratio of about 100 to one appears to be about as high as can be maintained consistently on presently available pinhole detectors.

A satisfactory light shield should be capable of following all changes in the sheet pass line, and should be isolated from the scanner to prevent transmission of vibration to the scanner. The development of a satisfactory light shield is urgently needed.

SUMMARY

It is apparent that much progress has been made during recent years in the development and application of pinhole-detecting equipment. It should be recognized, however, that unless maintenance is continued at a very high level, the performance of the most modern detectors will be no better than that of the earliest models.

Even with the most efficient pinhole detectors, some perforations will escape detection and the nondetected holes will probably be about in proportion to the frequency of the perforations produced; consequently, every known effort should be made to minimize the causes of perforations.

DISCUSSION

PRESENTED BY

R. V. CORDINGLEY, Assistant Superintendent, Metallurgical Dept., Indiana Harbor Works, Youngstown Sheet and Tube Co., East Chicago, Ind.

H. N. SNIVELY, Application Engineer, Steel Mill Section, Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.

R. V. Cordingley: It was pointed out that maintenance of pinhole detecting equipment should be continued at a very high level. We have found that the average maintenance man is not qualified to perform this service and that specialists are required on an around-the-clock basis if optimum performance is to be obtained.

With reference to the final paragraph in the paper, there is good reason to believe that variations in pinhole frequency among tin plate suppliers, as reported by several of the consumers, is more directly associated with the frequency of pinhole production during processing than with the efficiency of the pinhole detectors. It is certainly true, however, that even the mills doing the best job of minimizing the causes of pinholes still require the best detection equipment available.

H. N. Snively: I would particularly like to emphasize Mr. Rendel's remarks regarding maintenance. He has given a very clear picture of the maintenance problem. The high quality of steel demanded by the users requires a high grade of electronic equipment. Not only pinhole detectors are involved, but other devices such as X-ray gages, width gages and the like. This specialized equipment demands specialized maintenance to minimize production outages and to maintain a high quality product. A 1954 model one-mil detector is easily capable of 1938 performance with improper maintenance. Ninety per cent of all major maintenance problems can be eliminated by proper installation, routine inspection, and regular cleaning.

Proper installation implies resilient, shockproof mounting, shielding from stray light, shielding from other electrical circuits, protection from cobbles, protection from natural sources of oil and dirt, and accessibility for maintenance.

Routine inspection of scanner and amplifier and regular cleaning of optical systems can be combined. Obvious failures of light sources and tubes can be replaced.

The remaining 10 per cent of maintenance problems is where the specialist is required. Just as you do not allow your 12-year old boy to repair your television set, you would not allow casual motor inspectors to repair and adjust complicated electronic equipments.

Another point which Mr. Rendel did not make, but which I would like to mention is that there is a real need for close cooperation between steel mill operating personnel and electrical equipment manufacturers to aid in the development of new and improved tools. For example, it took us several years and many discussions with various operating people before we were sure that there was any practical need for a pinhole detector with a sensitivity much greater than 5 mils. Another example, is the still unsolved problem, which Mr. Rendel mentioned, of a really good light shield, particularly of the floating shutter type. I realize in the past we have supplied a manual light shield which although it was an excellent shield, we knew would be replaced immediately by a floating shutter of local design. We built several floating shutters, but they were never as successful as those built by the mills themselves. Today however, the vastly increased sensitivity of the one-mil detector places a higher premium than ever on a good shield. We are trying to design a good shutter for this detector, but we need help to come up with a universally acceptable design.

One other point which Mr. Rendel made is the difficulty of rating any pinhole detector with respect to angular holes. The 1954 one-mil model referred to has detected many small holes with no projected area vertical to the strip. However, the minimum size of such an angular hole which can be consistently detected is impossible to define. The best system would appear to incorporate highest practical level of illumination on strip and maximum sensitivity at detector.

Our present 1954 model detector approaches these qualifications. Again we would like to emphasize Mr. Rendel's statement that the 1946 supersensitive 5-mil pinhole detector can be easily and inexpensively converted to the 1954 one-mil model merely by the addition of a new phototube tray.

An X-Ray Tin Thickness Gage for the electrolytic tin line

. . . . a non-contacting tin thickness gage has been developed which measures x-ray fluorescence of iron . . . . it can be mounted directly on the tinning line to give a continuous record of tin coating weight . . . . a precision of ±0.01 lb of tin per base box is obtained . . . . instrument stability is maintained over extended periods . . . .

By R. R. WEBSTER
Assistant Manager
Metallurgical Research
Jones and Laughlin Steel Corp.
Pittsburgh, Pa.

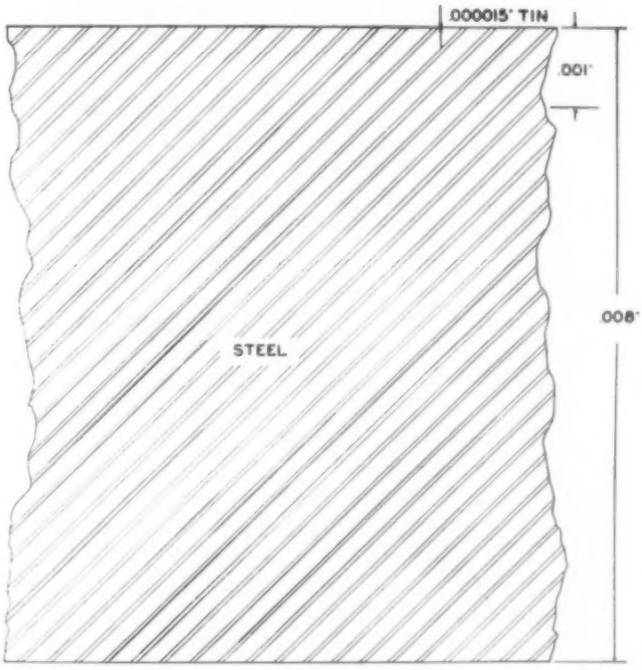
▲ PRIOR to the advent of the basic x-ray method to be described, no instrument was available for the measurement of tin on tin plate. Through the years, many schemes had been tried but the problem was a difficult one to solve. Figure 1, showing the dimensions of a piece of tin plate on a magnified scale, illustrates why the usual coating thickness devices fail on this material. A piece of tin plate with a nominal thickness of 0.008 in. will vary in thickness as much as ±0.001 in. The layer of tin covering the plate is only 0.000015 in. thick (0.25 lb per base box). Since the normal variations in base metal are approximately 100 times the total thickness of the tin coating, such apparatus as the various mechanical, electrical, magnetic and x-ray total thickness gages would not apply. Because of this situation, industry has been forced to rely on chemical methods of tin determination for the control of plating processes. The chemical method is slow, it is expensive in manpower and it destroys the sheet being tested. In short, it is a high cost, relatively unsatisfactory method of production control.

With tin selling as high as $1.37 per lb, and with an annual tin consumption by the tin plate industry of approximately 82,000,000 lb, there has been considerable pressure to conserve tin by every means available. Better control of the plating operation was one possible approach to conservation.

The advent of the modern electrolytic tinning lines that operate at speeds as high as 2000 fpm emphasized the need for some means of continuous supervision of the plating operation. Here, the delay entailed by the chemical coating determination limited the value of the results to principally a post-mortem check of the material produced and the line operator was forced to rely on the measurement of indirect factors such as line speed, plating current, solution temperature, etc., as an immediate guide to plating performance.

During x-ray diffraction studies on tin plate, one of the members of our laboratory developed an x-ray

Figure 1 — This sketch of an enlarged cross-section of tin plate serves to demonstrate the very large ratio of steel to tin in commercial tin plate and therefore the futility of total thickness measurements as a means of determining amounts of tin coating.



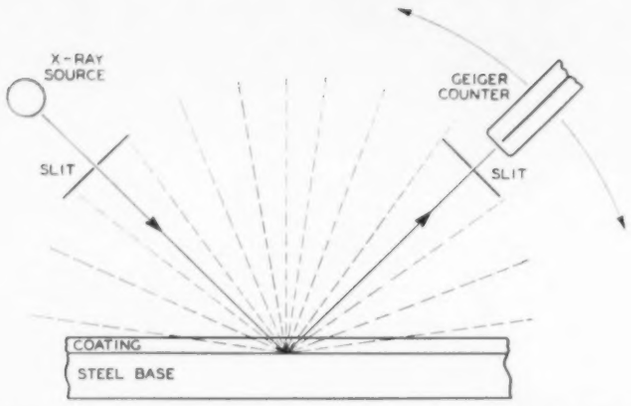


Figure 2 — When x-rays of the proper type strike a steel surface, iron fluorescence is generated and is radiated in all directions. A coating such as tin partially absorbs this radiation and a detector, in this case a geiger counter, measures the amount of iron fluorescence that escapes from the coating. The detector output can be calibrated in terms of coating weight.

method (see reference in Bibliography) for measuring tin coatings, using an x-ray spectrometer.

Briefly, this method makes use of iron fluorescence. Figure 2 illustrates the effect. An x-ray beam from a copper target strikes a sheet of tin plate, penetrating through the tin into the iron. The x-ray beam causes iron to fluoresce, giving off characteristic iron radiation.

As the iron fluorescence leaves the steel sheet, it is partially absorbed in the tin coating so that the amount received by a radiation detector placed close by will decrease with increase in tin thickness. The output of the radiation detector can therefore be used to determine the thickness of the tin coating.

In considering the application of the x-ray tin-thickness method to the routine measurement of tin on steel, it appeared that, while the direct reading x-ray spectrometer is an excellent piece of laboratory equipment, it has several limitations as a mill control instrument. These include:

1. Only small samples can be accommodated.
2. The x-ray beam covers a section about $\frac{1}{8} \times \frac{5}{16}$ in. which is too small to give a representative measurement of tin thickness; any local surface irregularity would have a major effect on the reading obtained.
3. The geiger counter used in this equipment is fragile; it changes in sensitivity with use and the accompanying electronic circuit is affected by high humidity. Its measuring time is rather long — approximately one minute being required to obtain suitable accuracies.
4. Strip position and x-ray beam angle are critical, since characteristic line spectra should be avoided.

While the diffraction equipment was limited in its usefulness as a control, this in no way invalidated the basic measuring principle, so it was decided that new equipment fitted to the particular needs of the mill should be designed. In addition, plans were made to apply the gage directly on the tinning line so that maximum benefit could be obtained from it.

DEVELOPMENT OF MILL GAGE

The first experimental model of the gage employed a water-cooled, copper-target, x-ray diffraction tube and a photomultiplier-type, fluorescent-screen-activated x-ray detector. In the interest of simplicity, both in x-ray supply equipment and photomultiplier auxiliaries, a self-rectifying x-ray power system was used. This generated x-rays in discrete pulses, 60 times per second. The x-rays excited fluorescence in the steel base of the tin coated sample and the resulting radiation escaping from the tin surface was detected by the photomultiplier, amplified and indicated on an a-c vacuum tube voltmeter or recorder. The equipment is sketched diagrammatically in Figure 3.

Unlike the spectrometer, the new gage used no beam collimation or filter, either on the x-ray tube or on the detector. This arrangement resulted in much greater usable x-ray energy and more efficient detection since a relatively large section of tinned sample could be irradiated (approximately 2½ sq in.) and, in turn, a larger amount of the fluorescent radiation could be received by the detector. In addition, the uncollimated and unfiltered x-ray beam tended to cover or mask the diffraction lines so that the angles between the x-ray source, sample and detector were no longer critical.

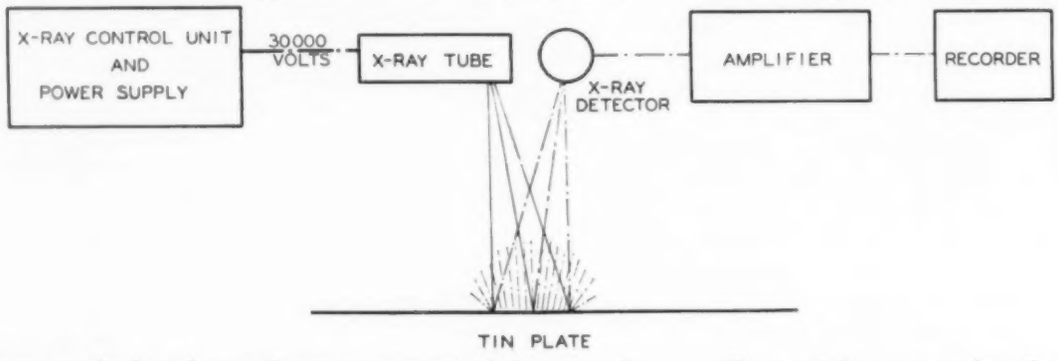


Figure 3—A block diagram of the first model of the tin thickness gage.

Tests of the gage, using tin plate over the range of 0.0 to 1.0 lb per base box, showed that the output voltage of the instrument was a function of tin coating thickness. Laboratory instruments employing variations of this basic gaging method are being used in tin mill production control. This work has been adequately described elsewhere.

While tin plate could be measured by this equipment, stability was a serious problem. The indicator would show variations as high as 20 per cent in periods as short as a minute. Voltage regulation was placed on the x-ray and photomultiplier power supplies with the result that the rapid drift was reduced to about 12 per cent which was still far too great for commercial application of the gage. Investigation showed the observed instability to be the sum of individual drifts from several sources. Briefly these were:

1. Statistical instability in x-ray output, a phenomenon characteristic of low-flux density x-radiation.
2. Effect of target voltage variation on x-ray output. The output of an x-ray tube varies as about the square of the applied voltage so that minor voltage fluctuations have a marked effect on output.
3. Erratic x-ray tube cathode heater current. Small changes in cathode heater current produce relatively large changes in x-ray output.
4. Voltage dependence of photomultiplier gain. The output varies as approximately the sixth power of the supply voltage.
5. Fatigue of photomultipliers with use.
6. Fatigue of phosphors with time and use.

It is not possible to completely compensate for all of the above effects and, while correction can be made for some of them, the additional equipment needed would be complicated and difficult to maintain.

DESIGN OF A NULL-BALANCE GAGE

At this point the decision was made to modify the gage so that accuracy would not be dependent on the stability of the x-ray source and detector. This could be accomplished by using the gage only as a comparator and then matching the unknown tin plate with samples of known coating weight until identical readings were obtained on each. The coating weight of the unknown would then be the same as the standard. The new gage is so designed that the comparison is made automatically and rapidly (30 times per second). Under these conditions relatively fast drift of the measuring components has little effect on instrument accuracy. By means of a unique design of standard sample, only one is needed and this is automatically positioned.

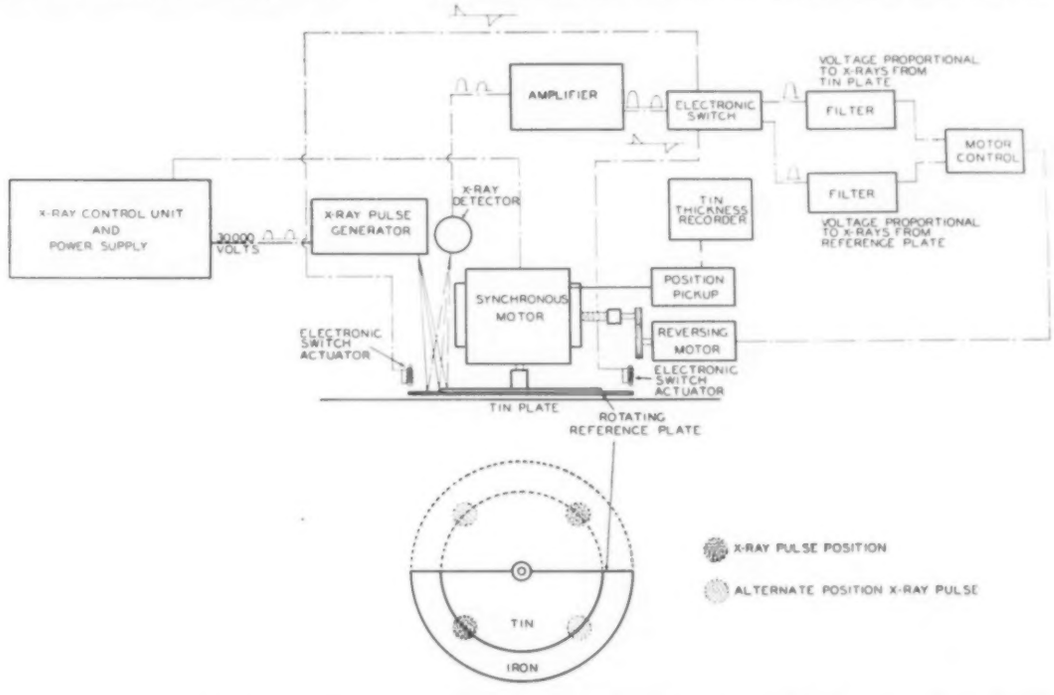


Figure 4 — The block diagram shows the major components of the final gage model employing the null-balance design.

DESCRIPTION OF GAGE OPERATION

Figure 4 is a block diagram of the gage as now constructed. The x-ray source is the same as was used in the previous experimental model and produces x-rays in the form of pulses — 60 per sec. with a pulse duration of somewhat less than 1/120 sec. The photomultiplier-type x-ray detector also is identical with that employed in the previous unit and contains a type-B fluorescent screen as the means of transforming x-ray energy to visible light.

Here, however, the similarity ceases. Instead of obtaining coating weight from the photomultiplier output, the signal is used to compare the tinned sample with an adjustable standard or reference plate until identical readings are obtained. In order that the standard may be exposed to the same x-ray beam that irradiates the tin plate, the standard is made in the form of a semicircular plate. This is rotated about its radial axis in such a way that during one x-ray pulse the standard is struck by the beam and, on the next pulse, the standard is moved out of the way and the tinned sample is irradiated. To keep the standard in proper step with the x-ray pulse, a synchronous motor is used to rotate the standard.

The standard must be adjustable to a wide range of coating weights, and it may be visualized as a tin coated plate with the thickness of tin varying from nothing at some large radius to a very heavy coating at a small radius. By moving the axis of rotation of the plate closer or farther from the centerline of the x-ray beam, the fluorescent radiation from the standard will vary. By proper choice of position of the rotation axis of the plate, the radiation from the plate can be made equal to that from any given sample of tin plate. In practice, it is not feasible to manufacture a standard plate with a closely controlled, variable tin coating, so instead, the plate is produced with an outer surface of plain steel and a smaller semicircular section of tin. The tin-to-steel intersection is carefully machined to present an accurate circular path and the radiation received from the standard is controlled by the amount of the x-ray beam striking the iron. The rest of the beam is absorbed by the tin. With an x-ray beam of controlled area, the behavior of this standard is identical to one with a wedge type coating. Figure 5 is a photograph of the standard mounted on the synchronous motor.

Figure 5 — The standard is mounted on the synchronous drive motor. The large semi-circular disk is iron. The smaller semicircular section is made of tin. The entire assembly is moved to expose more or less iron to the x-ray beam to effect a balance.

If the standard is always maintained in a position such that the amount of radiation from it and from the tinned sample are identical, then coating weights can be calibrated in terms of the position of the rotating axis of the standard. Normal change in axis position is approximately $\frac{9}{32}$ in. for tin samples ranging from black plate to 0.5 lb per base box per side. This motion is too small to be indicated directly so it is magnified electrically and shown on a position recorder as 10 in. total movement. The scale of 10 in. is then calibrated in terms of tin coating thickness.

Referring again to Figure 4, positioning of the standard is accomplished by mounting the synchronous motor on a set of ways and driving the assembly by means of a small reversible motor and screw. The reversing motor is controlled by the balancing equipment. The complete balancing apparatus consists of (1) a preamplifier fed by the photomultiplier x-ray detector, (2) a main amplifier, (3) a discriminator, and (4) a motor control.

The signals from both the standard and the tin plate sample are amplified and then separated in the electronic switch. The electronic switch also acts as a discriminator rectifier so that two d-c potentials are obtained from its output: one corresponding to the intensity of radiation from the standard and the other the intensity from the tin sample. These two potentials are then separately filtered and fed to the differential motor control that actuates the reversible motor. This motor then positions the standard. The balancing-motor control is designed to turn the reversible motor in the proper direction to maintain equal d-c potentials from the discriminator.

In order that the discriminator shall differentiate between pulses from the tin sample and those from the standard, magnetic pickups located close to the edge of the rotating standard sense the angular position of the standard and initiate the switching action of the discriminator.

MILL INSTALLATION

The gage was assembled in a heavy mill type housing (see Figure 6) and installed on the No. 2 electrolytic tinning line at the Jones & Laughlin Steel Corp. tin mill. Figure 7 shows the equipment located at the puller roll after the last strip drier. The gage head is mounted on a lathe bed and carriage, and equipped with a motor drive so that the gage can be set to measure the tin coating at any position across the width of the strip. The cross-feed on the carriage is used to correctly space the gage from the strip. The gage to strip clearance is 1.5 in. and 0.01 in. variation of this spacing changes the gage reading approximately 0.01 lb per base box. The puller roll is rubber faced and is occasionally recut

Figure 6 — The standard and its drive motor are visible at the rear left. The long cylinder in front is the x-ray tube. The rectangular box contains a preamplifier for the photomultiplier tube.

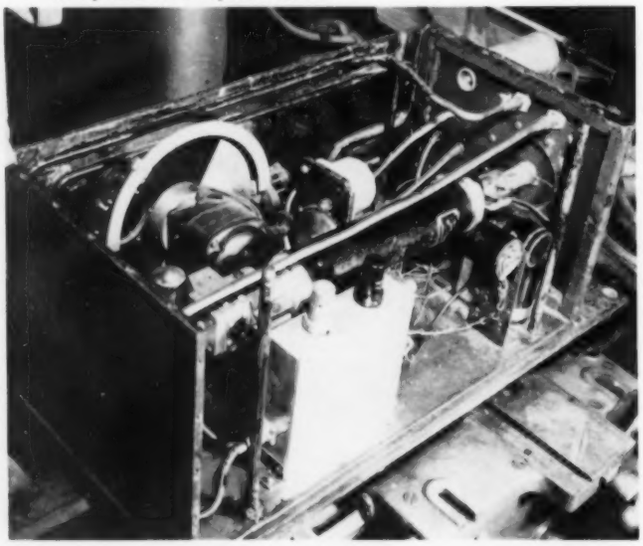


Figure 7 — The gage head is to the left, mounted on a lathe carriage. The puller roll over which the tin plate passes is in the center. The strip chart tin weight recorder is to the right, and the gage position indicator is mounted at the top of the recorder.

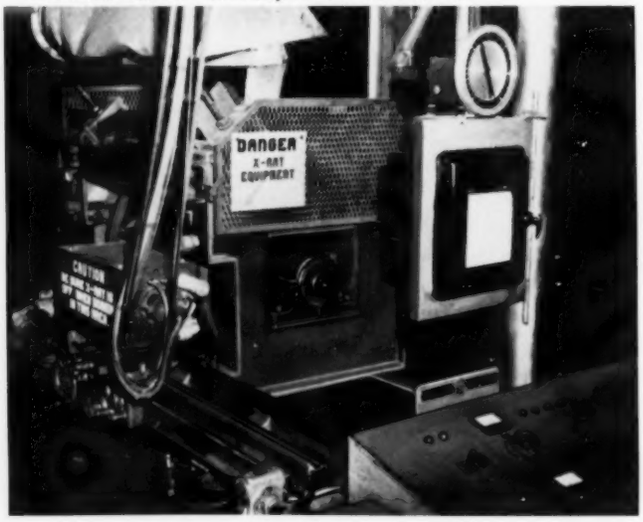


Figure 8 — The cabinets contain the x-ray power supply and auxiliary electronic gaging apparatus.

to true the surface. When this occurs, the gage to strip spacing must be readjusted.

On the right side of Figure 7 is the strip chart recorder mounted above the control desk. It is calibrated to read from 0 to 1.0 lb per base box tin coating weight. At the top of the recorder is an indicator that shows the gage position relative to the width of the strip. The x-ray power source and auxiliary electronic equipment are mounted above and to one side of the tinning line. The cabinets housing this apparatus are shown in Figure 8.

The gage location is not a desirable one from the point of view of the instrument designer, but represents a compromise that had to be made in adapting the instrument to an already existing tinning line. The gage head is located under a strip drier and in spite of the hoods and shields, the hot air blast could not be completely diverted. At start-up on a cold day, the ambient temperature may be as low as 45 F, while during the summer months, after continued operation, the temperature of the gage head could reach 150 F. A chemical treating tank is situated beside the gage and in case of a wreck, the gage can be showered with acid. The induction brightener is located in the immediate vicinity and radio-frequency fields of high intensity are present. By the use of water cooling in the gage head, careful sealing of the housing, and precautions to avoid ground loops in the electronic circuits, the gage was successfully adapted to the mill environment.

On completion of the continuous gage, an instrument based on the same measuring principles was constructed for use by the tin mill control laboratory to check individual sheets. This instrument has a direct reading indicator calibrated for the range 0 to 1.25 lb per base box per side. The apparatus is shown in use in Figure 9.

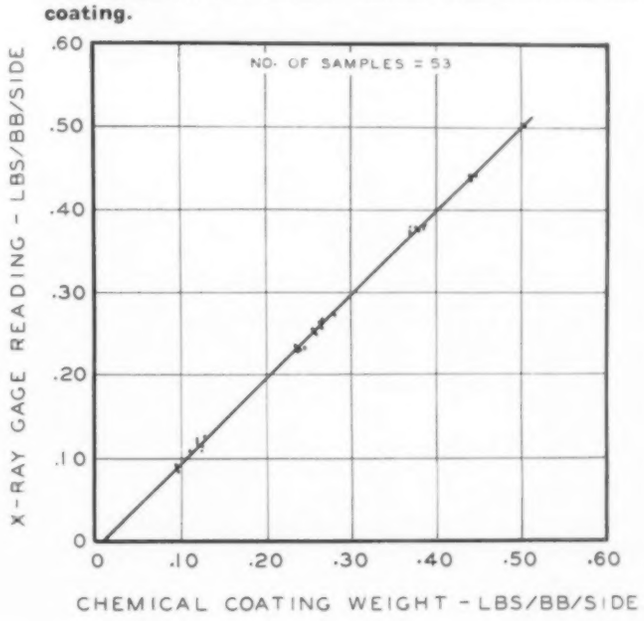
Figure 9 — The gaging unit is mounted above the table and the x-ray beam projects downward on the surface of the sheet. The indicator located at the front of the gage housing gives the coating weight in lb per base box per side.

PERFORMANCE

The prototype continuous gaging unit has been in 24-hr per day operation since 1951 and gives every indication of being an entirely practical unit for mill control. The instrument is accurate to approximately 1 per cent of full scale reading and will maintain this accuracy over extended periods. As a precautionary step, the gage is checked once each 24 hours using a standardized sample of tin plate. However, calibration adjustments are seldom needed.

The production of standard samples for checking the x-ray gage has posed somewhat of a problem. Chemical methods do not appear to have quite the precision of the x-ray method, and in addition they are destructive so that the plating area actually checked by chemical means is no longer available for use as a standard. By

Figure 10 — The data indicate good correlation between x-ray gage and chemical determinations of the tin coating.



sorting similar samples with the x-ray unit and then checking part of these chemically, a series of standards was developed. In this work the Referee chemical method gave the most reproducible results. Figure 10 shows a typical gage calibration using the Referee method.

ADVANTAGES OF CONTINUOUS GAGING

Several benefits are gained from continuous gaging: (1) malfunctioning of the line becomes immediately apparent so that a minimum of substandard material is produced, (2) the line can operate close to the ordered weight without the danger of drifting beyond the specifications, and this can result in tin savings, (3) the line can be quickly shifted to the production of tin plate of different coating weights without delay for chemical checks and with practically no loss in product, and (4) a record of line performance is available for supervisory use.

MEASUREMENT OF OTHER COATINGS AND MATERIALS

Theoretically it appeared that the x-ray tin thickness gage was not limited to the measurement of tin coatings. In order to explore other possible applications in a preliminary way, a number of steel samples coated with various metallic materials were tested.

Since intimate contact of the coating and the steel base did not appear to be necessary for proper gage operation, consideration also was given to the measurement of thin sheets of metal and organic materials using a steel backing plate for the generation of characteristic iron radiation. In all this work, the gage was applied in the same manner as when testing tin plate, and no changes were made either in equipment or adjustments.

Metallic coatings successfully measured included aluminum, chromium, silver and cadmium. Borderline results were obtained with copper and zinc, and further gage development would be needed to make satisfactory determinations on these two coatings. The instrument adequately handled sheet materials such as aluminum, cellulose acetate, nylon, and typewriter paper. Examples of data obtained are shown in the graphs of Figure 11. Since in the measurement of the sheets a backing plate of steel is required, the gage would be equally satisfactory on these and similar materials applied as finishes on steel.

PERSONNEL PROTECTION

In any work dealing with the industrial use of x-rays, the protection of personnel from exposure to such radiation must be considered. In the case of this equipment, precautions have been taken to see that stray radiation is held well within the tolerance limit. When the gage head is in the normal position in the mill the x-ray beam strikes the tin plate and puller roll. When the gage is racked out of the mill, the puller roll no longer acts to screen the beam and therefore an interlock is provided that automatically stops the x-ray target current. As an extra precaution, the area immediately surrounding the gage is posted and the operators are instructed to shut off the gage when working in the immediate vicinity.

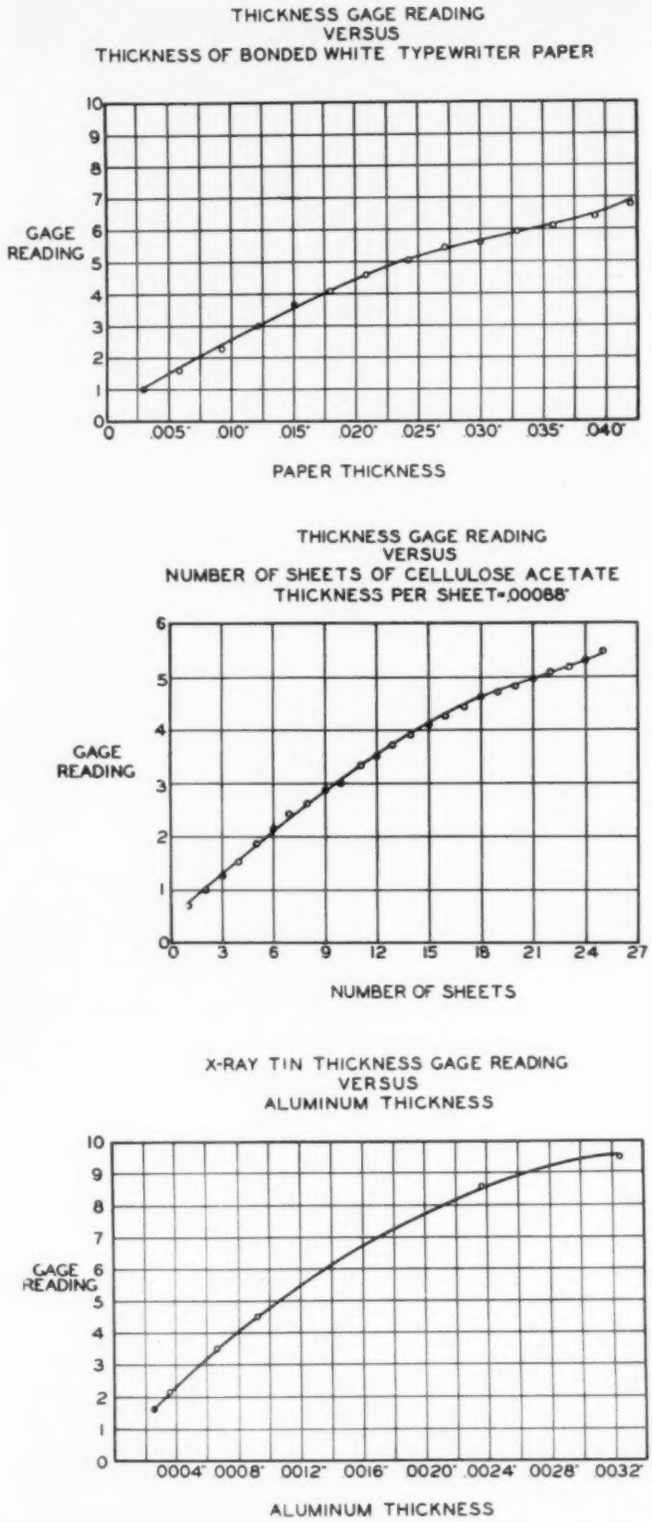

THICKNESS GAGE READING
VERSUS
THICKNESS OF BONDED WHITE TYPEWRITER PAPER
GAGE READING
0 1 2 3 4 5 6 7 8 9 10
0 .005" .010" .015" .020" .025" .030" .035" .040"
PAPER THICKNESS
THICKNESS GAGE READING
VERSUS
NUMBER OF SHEETS OF CELLULOSE ACETATE
THICKNESS PER SHEET=.00088"
GAGE READING
0 1 2 3 4 5 6
0 3 6 9 12 15 18 21 24 27
NUMBER OF SHEETS
X-RAY TIN THICKNESS GAGE READING
VERSUS
ALUMINUM THICKNESS
GAGE READING
0 1 2 3 4 5 6 7 8 9 10
0004" 0008" 0012" 0016" 0020" 0024" 0028" 0032"
ALUMINUM THICKNESS

Figure 11 — Other materials besides tin can be measured with the gage.

ADDITIONAL INSTALLATIONS

As a result of experience with the prototype continuous gage the decision was made to equip the remaining electrolytic tinning lines at J&L. The new gages are equipped for continuous scanning so that variations in coating across the width of the sheet can be recorded automatically. The installation of two gages has just been completed on the No. 3 tinning line and are shown in Figures 12 and 13. The recorders are located at the

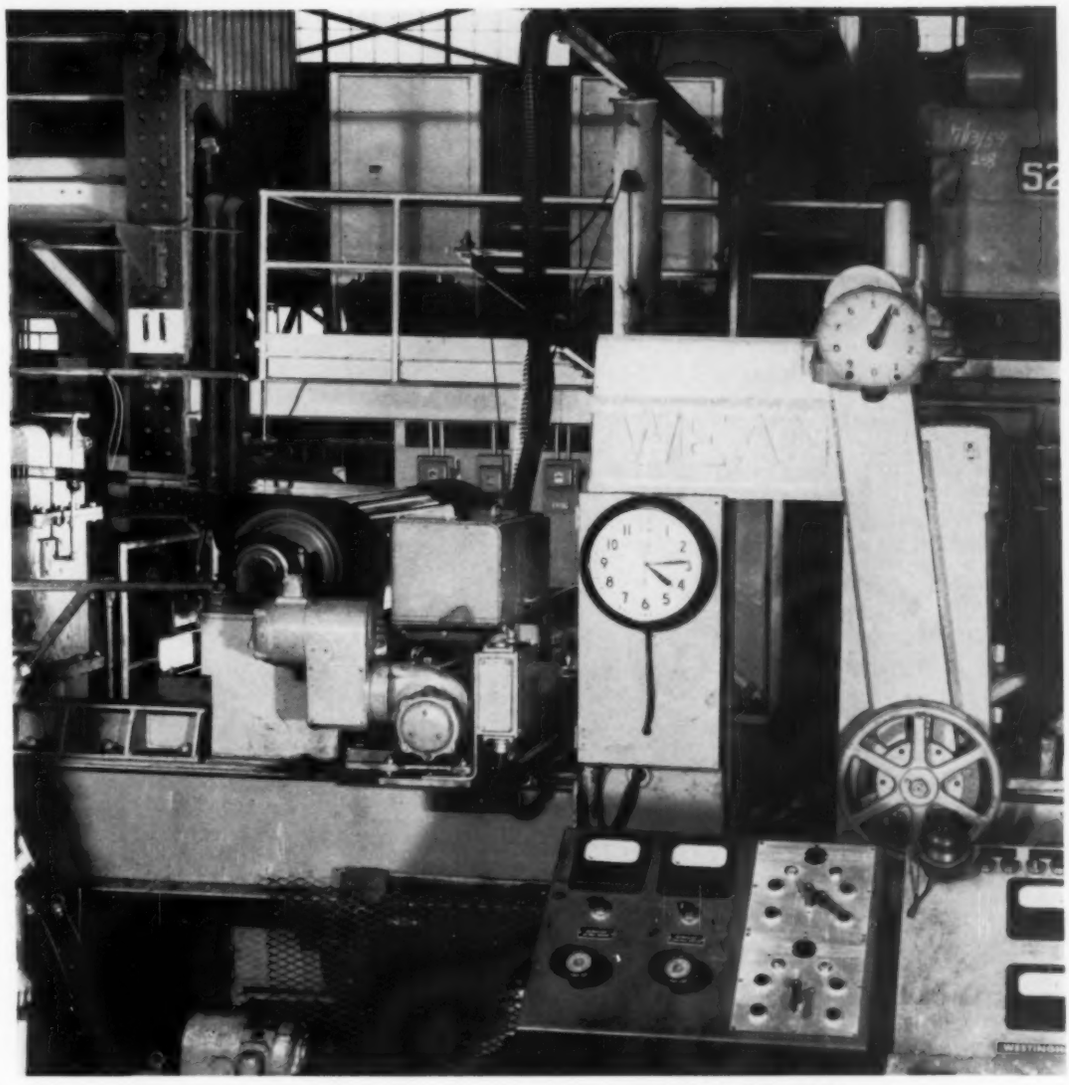
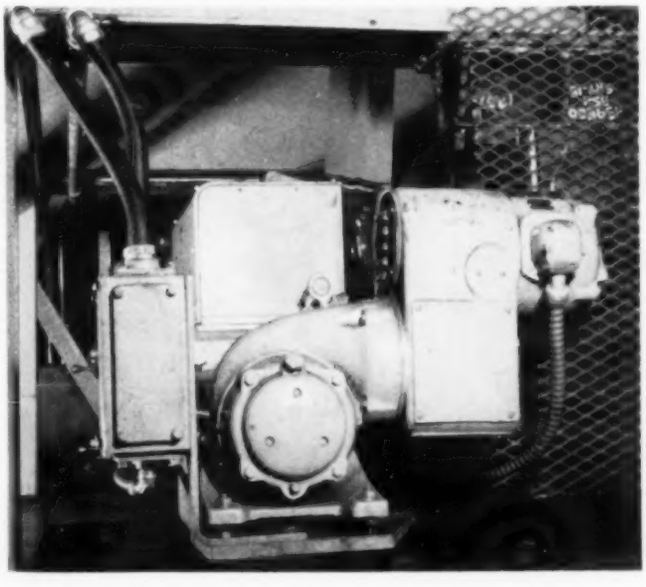


Figure 12 — Two gaging units are mounted at this location. The upper unit faces the roll in the center of the picture and measures the top surface of the tin plate. The bottom gage is almost directly below it and gages the bottom surface of the strip. The strip chart recorders are located at the plating control stations and are not shown in this view. The auxiliary electronic equipment is mounted in the cabinets on the platform shown at the top of the picture.

plating control stations. The installation at No. 1 line is underway and with its completion all the electrolytic tin plate produced by Jones & Laughlin will be gaged by this means.

Figure 13 — The descending strip is at the upper center of the picture. The gage head faces the strip as it passes over the roll. The motor drive for the automatic traverse is in the immediate foreground of the picture.



BIBLIOGRAPHY

1. "*An X-Ray Method for Determining Tin Coating Thickness on Steel*," by H. F. Beeghly, Journal of the Electrochemical Society, Vol. 97, No. 4, April 1950. (U. S. Patent No. 2,521,772).

2. "*X-Ray Tin Coating Gage*," by G. E. Pellissier and E. E. Wicker, Electrical Manufacturing, May 1952.

DISCUSSION

PRESENTED BY

E. H. BROWNING, Manager, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

R. R. WEBSTER, Assistant Manager, Metallurgical Research, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

J. K. SARGENT, Jones and Laughlin Steel Corp., Aliquippa, Pa.

E. H. Browning: Are you using this instrument while the tin is in a matted condition or flowed condition; that is, prior to or after reflow?

Since what you have described appears to be quite a unique detecting system that is giving indication of what the strip plating thickness is, has there been any work done or thought given to the possibilities of using this as a vernier type of control on the main control for plating current?

R. R. Webster: At present the measurement is made on the reflowed tin plate. However, it can be made on the mat finish. We have tried it both ways. The best location for the gage happened to be where the material had been reflowed.

Now, as far as the automatic control tin plating line is concerned, yes, we have thought about it. We have not done anything yet. I think, though, that before too long something will be done to tie the instrument to the line so that, rather than have the operator read the strip chart recorder and then make corrections, the gage itself will control the tin thickness.

J. K. Sargent: Back in 1951 when the first gage of this type went into No. 2 tin line the operators were curious, but they had to be shown. However, as soon as the gage had been adapted to its mill environment, which took some time, it was not long before the operator started leaning on it. We believe a measure of its usefulness as a production tool can be determined by the speed with which operators respond if the gage gets a little off. Occasionally it does and the maintenance people get immediate responses.

There is no question as to what the line is doing at any time. The line operator has but to glance at the chart and he knows whether or not he is on the beam. Coating weight adjustments are quickly and easily made, and the results of the adjustments can be read on a chart within fractions of a minute after they are made. There is none of the former delay of:

1. Waiting for the plate strip to reach the tension reel.
2. Cutting off the coil.
3. Obtaining a sample.
4. Sending sample to the laboratory.
5. Running chemical coating weight determinations.
6. Filling out the report and
7. Sending it back to the line.

LABORATORY GAGE

As a result of performance of this gage, the second gage, designed for cut samples was made for checking electrolytic coatings in the laboratory. Figure 14 shows how fast this gage was put to use after being taken over by our metallurgical people. The dips in the curve indicate points where chemical testing methods were used while adjustments were made on the gage. This gage has supplanted all of the chemical testing formerly made for tin line coating weight control. We periodically check this instrument with standard samples.

The stability of the gage was determined by automatically taking reading every 7.5 minutes continuously for 72 hours on standard samples. Figure 15 illustrates the results on a standard sample with a coating weight of 0.38 lb per base box per side. Here 99.1 per cent of the 569 readings taken were within a tolerance of ± 0.005 lb/bb/side. This same test was repeated throughout the coating weight ranges. At 0.08 lb/bb/side, 100 per cent of the readings were within ± 0.005 lb/bb/side and at 0.70 lb/bb/side, 97.5 per cent of the tests were within ± 0.008 lb/bb/side.

Here is where we have to stop and marvel. When we state that the gage is stable to ± 0.005 lb/bb, we are saying that, in the terms of the coating thickness, the gage is stable to a tolerance of ± 0.3 of one-millionth of an inch. To be frank about it, we had hopes for the gage, but we had not anticipated stability of this order and we are quite pleased with its performance.

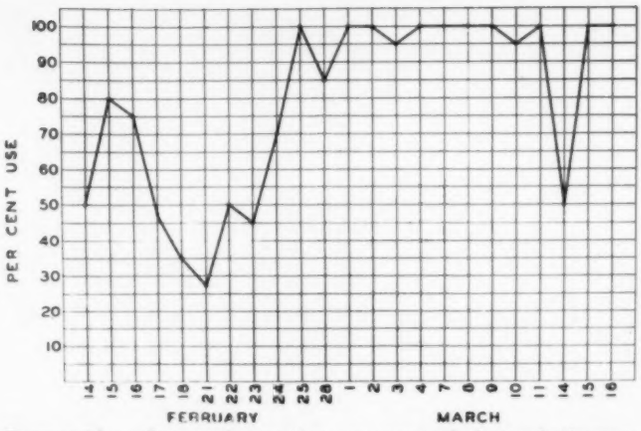


Figure 14 — Curve shows the per cent of electrolytic production which was tested by the sheet model gage. Quick adoption is illustrated by the curve.

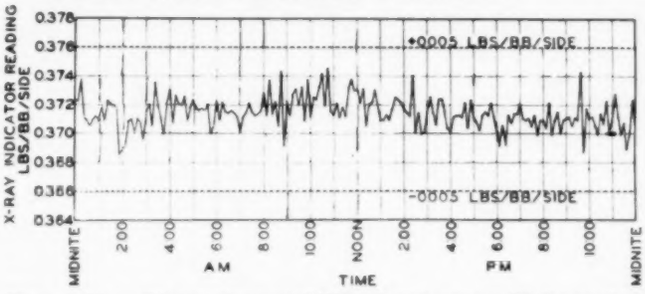


Figure 15 — Chart gives stability check over a 24-hr period on the sheet model x-ray gage on an 0.37 lb per base box per side sample.

PROGRESS OF GAGE INSTALLATIONS

To give you a report on the progress of our use of these gages, the two gages on No. 3 tin line have just been calibrated and last week went into limited use. The next step is the calibration of our No. 1 tin line gage which has just been installed. As soon as this work is accomplished, investigation will be started to attempt calibration of the laboratory gage for hot dip coating weight determination, with the ultimate aim being to eliminate routine chemical coating weight determinations except for routine checking of the x-ray gages.

BENEFITS OF GAGE

Those who are familiar with continuous tinning operations can readily see the following areas of savings:

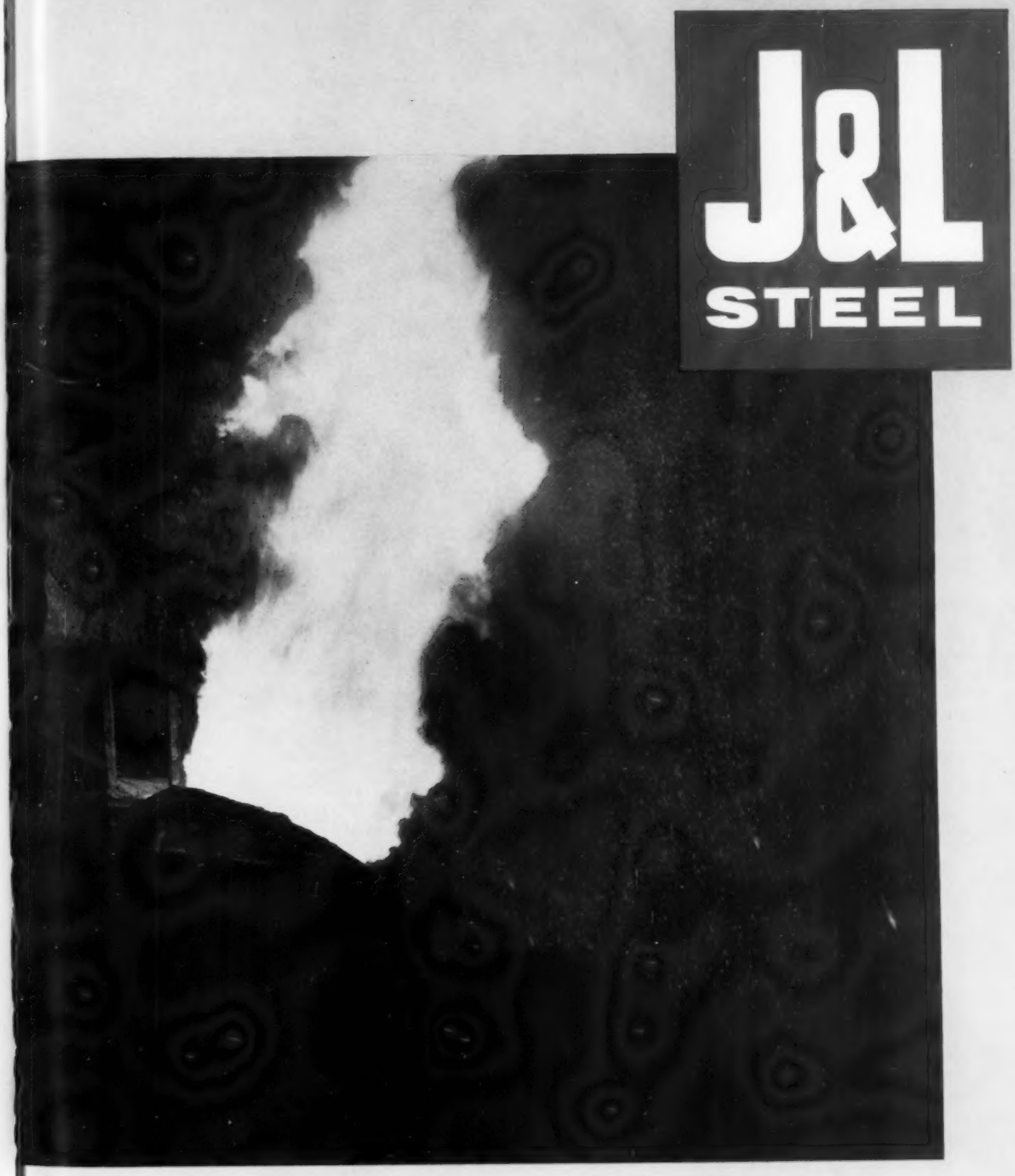
A. Improved tin line control, and as a result:
   1. Higher yield to prime product. This area of savings is enhanced by the fact that the gage is non-destructive, and it eliminates considerable sampling of product.
   2. Better quality through improved coating uniformity.

B. Release of trained personnel to other areas where they are needed.

C. Reduced laboratory chemical costs.

D. Elimination of retinning coils for low coating weight.

In conclusion, we feel Mr. Webster's work will give J&L, and the industry, a practical tool which will help us produce a lower cost, better quality product.



Jones & Laughlin . . .

ALIQUIPPA WORKS

J&L STEEL

Jones & Laughlin...

ALIQUIPPA WORKS

By T. J. ESS

▲ SHORTLY after the start of the present century, Jones & Laughlin Steel Co., which had just been formed by the merger of Jones & Laughlin's, Ltd. and Laughlin & Co., Ltd., had reached annual capacities of more than 1,000,000 tons of iron and 1,000,000 tons of steel. Production facilities were located on opposite sides of the Monongahela River in the city of Pittsburgh, which by that time had grown around the plants, hemming them in.

Since further expansion was desired, particularly in order to broaden the variety of products, it was deemed necessary to build elsewhere. In 1905, land was acquired at Woodlawn, Pa., about 20 miles down-river from the Pittsburgh plant. The site had been an amusement park and farm land. Ground was broken for the new plant in 1907. To help pay for this large project, the company borrowed $20,000,000 on mortgage bonds.

The first blast furnace was completed in 1909. Two more were finished in 1910, a fourth in 1912, and a fifth in 1920. Construction of steel producing and rolling facilities began in 1909. Tinplate was first rolled in 1910. Open hearth steel was first produced in 1912 and bessemer steel in 1914. By 1912, the plant had a capacity of 250,000 tons of ingots per year, and by 1930, the annual capacity had grown to 1,420,000 tons of ingots. Products were principally billets, merchant bars and shapes, welded pipe, tinplate and wire. Seamless tube production started in 1927.

In 1947, continuous strip pickling and cold reducing facilities were installed for tinplate production, using hot rolled coils from the Pittsburgh Works. Also since World War II, a new rod mill was installed, replacing two old mills, new coke ovens have been constructed, and the blooming mill was rebuilt and electrified.

Today, Aliquippa Works occupies a site of 475 acres extending for about 4 miles between the left bank of the Ohio River and the Pittsburgh & Lake Erie Railroad. The location provides excellent transportation by river or by rail for raw materials and products. The plant has annual capacities for 2,190,000 tons of by-product coke, 1,800,000 tons of iron, 1,182,000 tons of open hearth steel and 582,000 tons of bessemer steel.

Aliquippa Works extends for four miles along the left bank of the Ohio River.

Its products include strip, bars, rods, skelp, tube rounds, cold rolled sheet, black plate, electrolytic tin plate, hot dip tin plate, wire (plain, galvanized, barbed, nails and staples), woven wire fence, buttweld and lapweld pipe, seamless tube, galvanized pipe and mechanical tubing.

RAW MATERIALS

Iron ore for the Aliquippa plant comes mainly from the Mesabi range, where the company's Minnesota Ore Division operates company-owned mines and mixes the ores produced in varying proportions to form ore groups of the desired analyses. These mines have facilities for crushing, screening and washing ore, and one mine has a heavy media separation plant.

The lake ores are shipped by boat to the lower lake ports and transferred into railroad hopper cars for shipment to the plant.

Additional ore is received from Benson mines, at Star Lake, N. Y., where the New York Ore Division produces magnetite ore which is beneficiated and sintered before shipping to the steel plant.

Analyses of the ores and sinters used at Aliquippa are given in Table I.

With full operations, the Aliquippa Works uses about 3,100,000 gross tons of iron ore and sinter per year, of which 80-85 per cent comes from the Lakes area.

Ore comes to the plant entirely by rail in hopper cars, which are unloaded by a 105-ton car dumper. The storage yard is 300 ft wide × 2000 ft long and is served by four 70-ton transfer cars and three bridges (one of 12½-ton capacity, two of 7½-tons). Normally, all ore and miscellaneous materials are unloaded by the car dumper into the transfer cars. These cars then deposit materials into pits for stocking in the yard by the bridges, or directly into the stock bins of the blast furnaces, as desired.

This storage yard will accommodate 1,500,000 gross tons of ore, sufficient to carry the plant through the winter season when lake shipping is closed. The various types of ore are piled separately. Cargoes of the same grade are bedded by layers in each pile.

Limestone and dolomite are quarried by the company's Blair Limestone Division at Martinsburg and Millville, W. Va. In addition, 40 to 50 per cent of the limestone requirements is purchased from quarries in the Youngstown area. Analyses of these fluxes are given in Table II. Stone is variously sized at 1 × 5 in., 4 × 2½ in. and 2½ × ¾ in.

Approximately 2600 gross tons of limestone are consumed per day at Aliquippa.

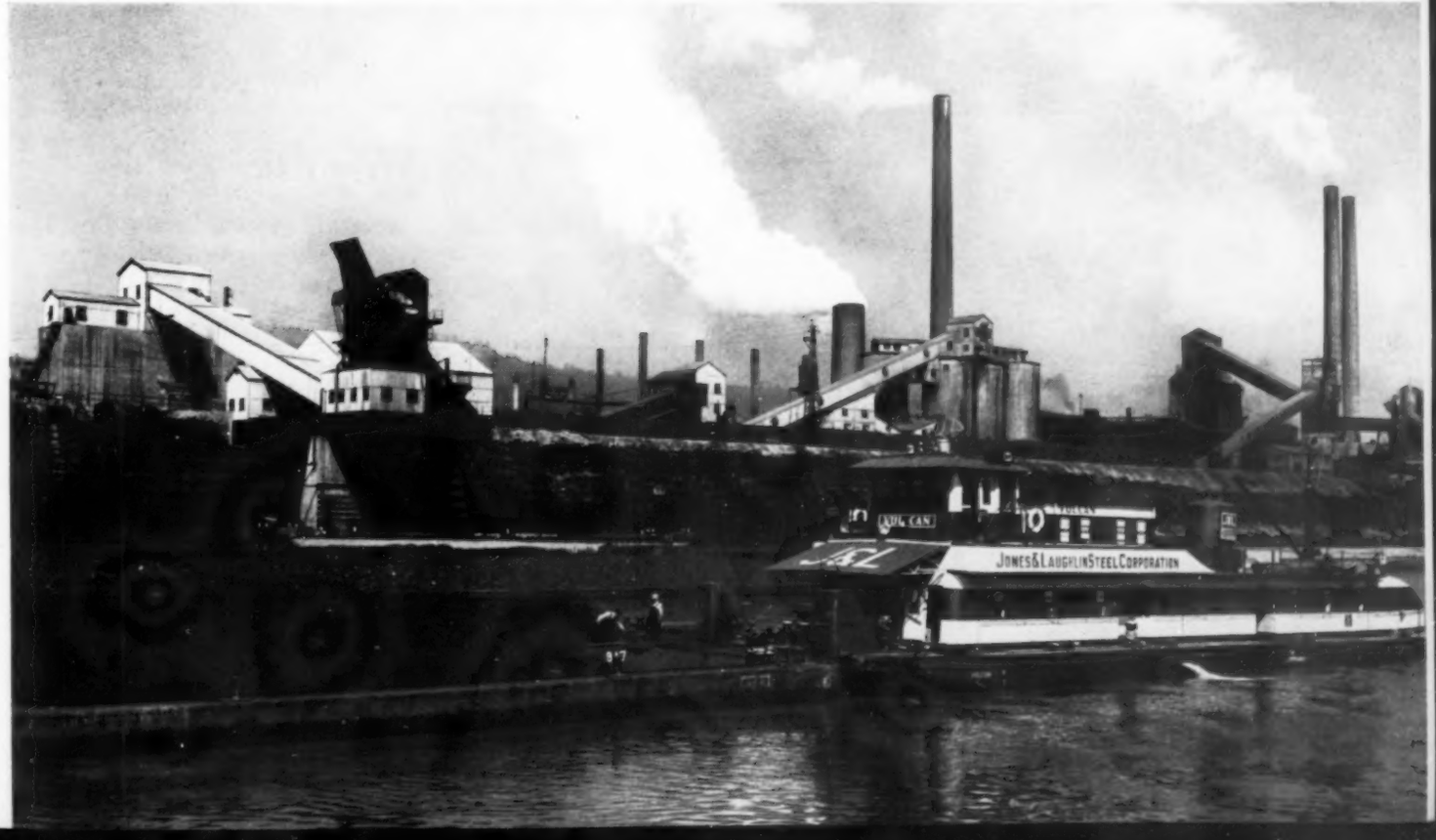
Coal for Aliquippa is provided mainly by the company's Vesta-Shannopin Coal Division, with mines in Washington and Greene counties in southwestern Pennsylvania, and the Twin Branch-Black Eagle Coal Division, with mines in Wyoming and McDowell counties in West Virginia.

High volatile coking coal comes from the Vesta mines, located near Fredericktown, Pa., with a capacity of about 20,000 tons per day. This coal is washed in a preparation plant at the mines, with the middlings being separated out and used as steam coal.

Low volatile coal comes chiefly from the Black Eagle mine in Wyoming county, W. Va., which produces about 1300 tons per day. This coal is hand picked before shipment. Some low volatile coal is also purchased.

Shannopin mine, near Poland, Pa., with a production

Coal comes to Aliquippa from company-owned mines up the Monongahela River. Unloading facilites may be seen in the background.



ADMIRAL BEN MOREELL
CHAIRMAN OF THE BOARD

C. L. AUSTIN
PRESIDENT

of approximately 3000 tons per day, provides most of the steam coal. This coal is also hand picked before shipment.

Table III gives analyses of these coals.

At Aliquippa, all coal is received in river barges and is unloaded at either of two locations. All coal for boilers and miscellaneous use, as well as all coal to be stocked, is unloaded at a station at the southern end of the plant. This station is served by a modern harbor with heavy concrete ice-breakers to protect the barges, as well as 16 ft diameter mooring cells and a steel dock. Barges are moved by a 430 hp diesel twin-screw boat.

Coal is removed from the barges by a double bucket line elevator which delivers the coal to a double roll crusher. Steam coal for immediate use is then delivered by conveyors either directly to boiler house bins or to cars for distribution by rail. Coal (either steam or coking) to be stored is taken from the crusher by conveyor to a coal storage yard. Coal is reclaimed from this storage by a bridge and moved by conveyor directly to the boiler house bins, to railroad cars, or back to river barges for delivery to the coke plant. This storage yard has capacity for 350,000 tons of coking coal and 20,000 tons of steam coal.

When additional storage is desired, coal is unloaded from barges at this same station and put into cars for rail delivery to an area at the north end of the plant. This yard has a 500,000-ton capacity. Coal is stocked and reclaimed by bull-dozer and mobile crane. The reclaimed coal is put into cars and unloaded at the coke plant by a rotary car dumper.

Coal intended for immediate use at the coke plant is unloaded at the second station down-river, which also has a modern harbor with ice-breakers, mooring cells, a steel dock and a diesel harbor boat.

At this station, coal is also unloaded from barges by a double bucket line elevator of 1500 tons per hr capacity. This elevator delivers directly to a single roll crusher which reduces the coal to −5 in. Crushed coal is delivered by belt conveyors to any one of four 500-ton surge bins. Each barge of coal is sampled automatically as it is put into these bins.

Normal coal consumption at Aliquippa runs 8850 tons of coking coal and about 1220 tons of steam coal per day.

COKE PLANT

Coal is removed from the bottom of the surge bins through feeder gates and taken by conveyors at a rate

A. T. LAWSON
VICE PRESIDENT — PRODUCTION

W. P. GETTY
ASST. VICE PRESIDENT — PRODUCTION

J. E. TIMBERLAKE
VICE PRESIDENT — SALES

TABLE I

Iron Ore Analyses

Source	Ore	Per cent (dry)								
		Iron	Silica	Phos-phorus	Manga-nese	Alumina	Lime	Mag-nesia	Sulphur	Per cent moisture
Minnesota Ore Division										
Mesabi Range	Blain Group	53.70	9.67	0.066	0.26	1.00	0.13	0.09	0.02	7.82
	Canby Group	54.01	11.10	0.040	0.18	0.73	0.11	0.08	0.02	6.42
New York Ore Division										
Benson Mine	Magnetite sinter	62.81	6.66	0.031	0.27	3.55	0.23	0.35	0.36	6.8
Plant sinter	.....	56.27	12.58	0.046	0.37	2.04	0.32	0.26	0.03	5.12
Purchased ores										
Mesabi Range	Newberry	53.46	10.89	0.035	0.26	0.44	0.27	0.17	0.01	6.97
	Williamson	51.83	10.40	0.066	0.34	1.15	0.22	0.17	0.01	8.67
Marquette Range	Cliffs Group	51.20	8.12	0.100	0.25	2.60	0.83	0.54	0.45	10.14

TABLE II

Limestone and Dolomite Analyses

	Purchased limestone		Martinsburg limestone	Millville dolomite
SiO_2	2.52	2.65	1.85	1.37
R_2O_3	1.86	1.99	0.89	1.05
CaO	52.18	52.16	50.72	30.67
MgO	1.09	1.04	3.15	20.37
P	0.025	0.023	0.011	0.009
S	0.052	0.106	0.086	0.048

of 750 tons per hr to a double roll crusher which reduces the size to −2 in. This crushed coal is again moved by conveyor belt to the coal blending bins. By assigning a particular grade of coal to each bin, as many as four grades may be blended in definite, exact grades to form the desired mixture.

Coal, drawn off the bottom of the blending bins by four feeder conveyors with weighing mechanisms, is collected on a single belt conveyor and delivered to hammer mills, where it is thoroughly mixed and crushed so that 52 to 55 per cent of the coal will pass through a ⅛-in. screen. The crushed mixture is then conveyed to the oven storage bins. One 4500-ton bin serves batteries No. 1 and 2. No. 3 and No. 4 batteries have a 3000-ton bin.

Coking facilities consist of four batteries of by-product ovens arranged in a single row. No. 1, 3 and 4 batteries are of modern underjet design, with ovens 15¼ to 18¾ in. wide, 40 ft 6½ in. long, and 13 ft high. These ovens take a normal charge of 17.25 tons of coal. No. 1 and 4 batteries each have 106 ovens, while No. 3 consists of 59 ovens.

No. 2 battery is composed of 81 ovens of gun-flue design with top cross-overs, each oven 15 to 17 in. wide × 40 ft 8 in. long × 14 ft high. Each of these ovens takes a normal charge of 18 tons of coal.

All batteries are underfired with coke oven gas, using 40 to 42 per cent of the gas produced. Air for combustion is heated in regenerators beneath the ovens. Normal gas pressure in the ovens during coking is 8 mm of water pressure. Flue temperatures average 2550 F, and stack temperatures about 625 F. Six 250-ft stacks serve the ovens, with drafts automatically controlled at 20 to 26 mm of water pressure.

Each battery is served by a three-hopper larry car operating along the battery top and carrying a carefully weighed charge for one oven. Each battery also has a combination pusher-leveler-door machine on the pusher side, a door machine and guide on the coke side, and a quenching car. Automatic interlocks and signal systems insure the pushing of the proper ovens as scheduled.

Coke, at temperatures of 1800 to 1850 F, is pushed into the quenching car, taken to one of the three brick quenching towers and then dumped on one of two 240-ft coke wharves.

After cooling on the wharf, coke is taken by belt conveyor to a screening station of 200-ton per hr capacity. Here coke is screened into three sizes: furnace coke,

P. H. DEVANEY
WORKS MANAGER,
ALIQUIPPA WORKS DIVISION

A. C. KELLER
ASST. WORKS MANAGER—PRODUCTION
ALIQUIPPA WORKS DIVISION

J. M. GEHR
ASST. TO WORKS MANAGER—PERSONNEL RELATIONS, ALIQUIPPA WORKS DIVISION

TABLE III

Coal Analyses

	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur
Vesta-Shannopin Division					
Vesta washed	8.0	35.37	56.87	7.76	1.33
Vesta steam	5.6	33.3	50.4	16.30	2.80
Shannopin	3.3	36.94	52.89	10.17	3.46
Twin Branch — Black Eagle Division					
Twin Branch	4.4	21.72	72.73	5.55	0.71
Black Eagle	4.4	19.80	73.29	6.91	0.75

over 1¼ in., under 4 to 6 in.; nut coke, over ⅞ in., under 1¼ in.; and breeze, under ⅞ in. Furnace coke and nut coke are both used in the blast furnaces, but are charged separately. Breeze is used principally as boiler fuel. At the screening station, all coke is loaded into hopper cars for transfer to the blast furnaces or to the boiler houses.

Normal coking time is 17 hours, giving 497 ovens pushed each day. This would require 8850 tons of coal, and produce 6065 tons of furnace coke and 375 tons of coke breeze. Of this furnace coke, about 4800 tons per day are used in the Aliquippa blast furnaces and 1265 tons are sent to the company's plant at Cleveland, Ohio. The coke has analyses averaging as follows:

	Per cent
Volatile matter	0.76
Fixed carbon	89.61
Ash	9.63
Sulphur	1.02

Modern equipment is installed for the recovery of the usual by-products of coal carbonization. Gas leaving the ovens is sprayed with weak ammonia liquor and cooled to about 80 C. The condensed tar and liquor are collected in decanters and separated by gravity. The tar goes to storage to await further distillation. Some ammonia liquor is recirculated to the collector mains for gas cooling, while the excess, after treatment to remove phenol, is put through a still to recover the ammonia.

The gas is next put through eight shell-and-tube, multi-pass primary coolers, where its temperature is reduced to 30 to 35 C.

Following the primary coolers, gas goes through three turbine-driven exhausters, each rated at 38,000 cfm. Any remaining tar vapor is then removed from the gas by electrostatic precipitators, after which the gas passes through ammonia saturators, final coolers and light oil absorbers, and finally, into an 80,000 cu ft holder.

In the saturator, the gas is bubbled through a dilute solution of sulphuric acid which combines with the ammonia to form crystalline ammonium sulphate.

There are four light oil absorbers, each 100 ft × 17 ft in diameter. The absorbent oil is normally circulated at a rate of 66,000 gphr and absorbs 2.00 to 2.25 per cent by weight of light oil.

Wash oil is put through two wash oil stills 50 ft 6 in. high × 9 ft in diameter, where steam removes the light oil. De-benzolized wash oil is cooled and pumped back through the absorbers.

Light oil vapor and steam from the stills flow to rectifiers and are separated into a liquid and a vapor. The liquid portion is removed and stored for further distillation. The vapors are condensed and pumped to the carbon disulphide still, where they are again separated into two parts. The more volatile products come off the top of the column and are condensed and collected as fore-runnings. Benzol and toluol come off the bottom of this column as a liquid and, after treatment with sulphuric acid and caustic soda, are separated in a second column. The heavier fraction from the light oil rectifiers is separated into xylol and crude solvent in a secondary still.

Benzol products in the semi-refined state are washed with sulphuric acid and neutralized with caustic soda to remove undesirable compounds, thus improving quality and color of the products.

By-products recovered include 93,000,000 cu ft of coke oven gas, 90,000 gal of tar, 200,000 lb of ammonium sulphate, 33,000 gal of light oils, 1500 gal of sodium phenolate and 400 gal of crude pyridine each day.

Surplus gas, to the extent of some 55,000,000 cu ft per day, is pumped at 5 psi pressure by three 23,800-cfm turbine-driven boosters to two 30-in. gas mains which extend throughout the entire plant.

Tar and crude pyridine are shipped to the company's Pittsburgh Works for distillation and the recovery of tar acids and pure pyridine.

BLAST FURNACES

Five blast furnaces provide a total iron-making capacity of 1,800,000 net tons per year. These furnaces form

Four batteries of by-product coke ovens provide capacity for the production of 2,190,000 net tons of coke per year.

This aerial view shows the five blast furnaces with their ore storage yard. In the background, along the river bank, are coal handling and coking facilities.

a line near the north end of the plant, paralleling the ore yard. Table IV gives principal design and operating characteristics of the furnaces.

It might be noted from Table IV that, except for hearth and bosh diameters, the five furnaces are remarkably similar in design. Also to be noted is the use of tapered linings, which are quite thick just above the mantle and thin out up through the stack and throat. This feature is primarily the result of the enlargement of the furnaces over the years, while keeping the original shell.

It is interesting to recall that the Aliquippa plant pioneered in the use of large hearths in blast furnaces. In fact, No. 5 furnace is said to be the first in the United States to average more than 1000 tons of iron a day for an entire year. This was in 1928. Also, in March, 1943, No. 3 furnace set a record for iron production with 48,505 net tons, a daily average of 1565 tons. This furnace also holds what is believed to be a world's record of 5,823,951 net tons of iron from one hearth and bosh lining, the campaign extending from June 13, 1933 until April 15, 1948.

All hearth cooling is done by cast iron staves 4¼ in. thick × 15 ft 4½ in. long, and conventional bronze cooling plates are installed in the hearth and bosh walls. No cooling plates are used above the mantle. Stockline protection is provided by rolled steel Z-sections built into the brickwork.

Each furnace is served by motor-operated double skip hoists, with skip cars of 122-cu ft capacity. Each furnace has a rotating distributor top, and all bell hoists are steam-operated.

The five furnaces have a common underground stockhouse and a ground level trestle carrying three tracks, two of which run over a double row of stock bins, while the third is for transfer car operation. No. 1 and 2

Iron from the blast furnaces is tapped into mixer type ladles for transportation to the steelmaking departments.

TABLE IV

Blast Furnace Data

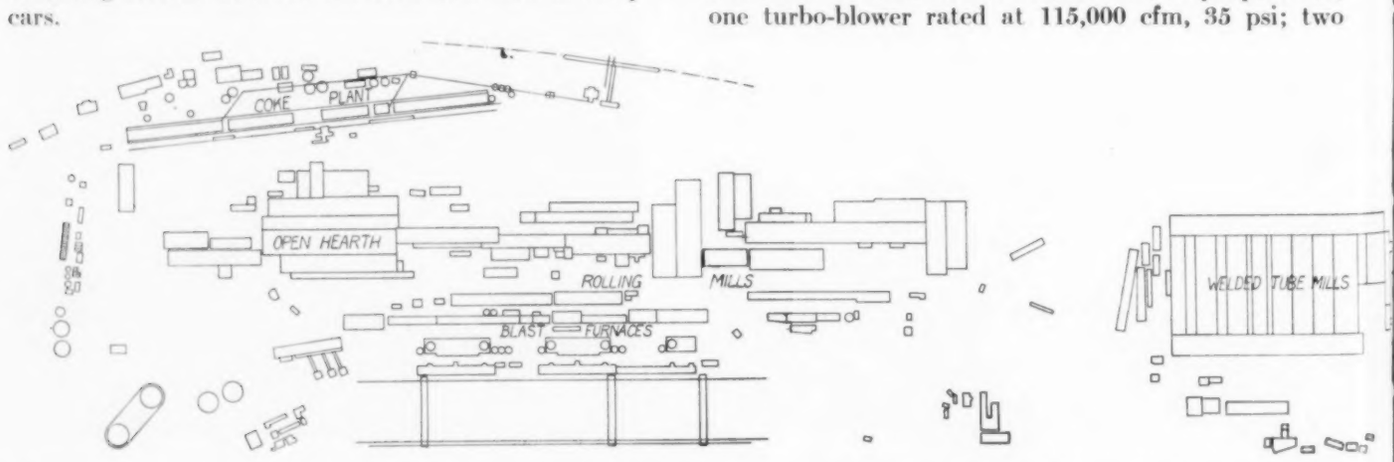
Furnace No.	1	2	3	4	5
Diameter of hearth, ft-in.	28-6	21-6	28-6	27-0	26-6
Diameter of bosh, ft-in.	30-0	24-4	30-0	29-6	28-9
Diameter of stockline, ft-in.	19-0	19-0	19-0	19-0	19-0
Height, iron notch to stockline, ft-in.	74-3	75-3	74-3	74-3	74-3
Height of crucible, ft-in.	10-6 3/4	10-6 3/4	11-0 3/4	10-6 3/4	10-6 3/4
Height of bosh, ft-in.	12-7 1/2	12-7 1/2	12-7 1/2	12-7 1/2	12-7 1/2
Height of straight section, ft-in.	5-2 1/4	5-2 1/4	5-2 1/4	5-2 1/4	5-2 1/4
Height of inwall section, ft-in.	43-0	44-0	43-0	43-0	43-0
Height, stockline section to top ring, ft-in.	18-7 1/4	18-7 1/2	18-7 1/2	18-7 1/2	18-7 1/2
Height, bottom to iron notch, ft-in.	1-9	1-9	1-9	1-9	1-9
Height, iron notch to cinder notch, ft-in.	3-9	3-9	3-9	3-9	3-9
Height, cinder notch to tuyeres, ft-in.	3-3	3-3	3-3	3-3	3-3
Working volume, tuyeres to stockline, cu ft	34,058	25,870	34,058	32,933	31,884
Bosh angle, deg-min-sec	86-36-0	83-35-51	86-36-0	84-20-44	85-54-28
Inwall slope, in. per ft	1 13/16	23/32	1 13/16	1 3/4	1 5/8
No. of tuyeres	18	12	18	16	18
Tuyere diameter, in.	6 1/2	7	7	7	7
No. of columns	12	12	12	16	12
Lining thickness, crucible, in.	45 1/4	41	45 1/4	51 1/4	45
Lining thickness, bosh, in.	31 1/2	31 1/2	31 1/2	31 1/2	31 1/2
Lining thickness, stack, in.	36-81	36-68	36-81	36-75	36-67 1/2
Lining thickness, throat, in.	13 1/2-34 1/2	13 1/2-34 1/2	13 1/2-34 1/2	13 1/2-34 1/2	13 1/2-34 1/2
Big bell diameter, ft-in.	14-0	14-0	14-0	14-0	14-0
Big bell angle, deg	55	55	55	55	55
No. of stoves	4	4	4	4	4
Stove diameter, ft	22	22	22	22	22
Stove height, ft	100	100	100	100	100
Checker openings, in. square	(3) 4 3/8 (1) 4 1/4	(2) 4 3/8 (2) 9	(3) 1 7/8 (1) 4 3/8	(3) 4 3/8 (1) 4	(4) 4 3/8 .....
Heating surface per stove, sq ft	(3) 136,000 (1) 176,400	(2) 136,000 (2) 44,300	(3) 135,200 (1) 136,000	(3) 136,000 (1) 118,500	(4) 136,000 .....
Blast volume, average, cfm	83,000	65,000	83,000	76,000	76,000
Blast volume, maximum, cfm	86,000	70,000	86,000	80,000	80,000
Blast temperature, average, F	1050-1100	1050-1100	1050-1100	1050-1100	1050-1100
Blast temperature, maximum, F	1250	1250	1250	1250	1250
Lb of ore per net ton of iron	3344	2942	3217	3246	3350
Lb of stone per net ton of iron	1080	948	1057	1018	1048
Lb of coke per net ton of iron (3 per cent H_2O)	1710	1658	1761	1607	1642
Lb of scrap charged per ton of iron	235	311	235	220	222
Lb of roll scale charged per ton of iron	50	127	113	118	.....
Daily iron production, average, net tons	1194	915	1166	1264	1211
Daily iron production, maximum, net tons	1300	950	1300	1275	1275
Lb of slag made per net ton of iron	1164	1034	1139	1084	1131
Lb of flue dust made per net ton of iron	220	169	158	297	157
Ratio, stone to mix, per cent	31.8	30.9	31.7	30.3	31.3
Fuel ratio (ore to coke)	2.17	2.10	2.00	2.12	2.10
Silica in mix, per cent	8.98	10.53	8.99	9.11	8.94
Actual yield, per cent	91.62	92.78	93.03	90.00	93.04

furnaces have 32 parabolic bins for ore and stone, and one large coke bin for each furnace. No. 3 and 4 furnaces are similarly arranged. No. 5 furnace has 26 bins for ore and stone, and one large bin for coke.

All limestone and miscellaneous materials are unloaded directly into the bins from hopper cars. Coke is likewise unloaded from hopper cars, and is passed over vibrating screens between the coke bins and the skip cars.

Two charging sequences are normally used: OOSCCC/ and OOOSCCCC/. Automatic charging sequence control is installed on No. 1, 4 and 5 furnaces, and this feature is scheduled for installation on No. 2 and 3 when next relined. Coke is charged by volume; ore and stone by weight.

Blowing equipment for the furnaces is comprised of one turbo-blower rated at 100,000 cfm, 30 psi pressure; one turbo-blower rated at 115,000 cfm, 35 psi; two



turbo-blowers rated at 45,000 cfm, 30 psi; and ten double vertical blowing engines with 84 in. × 60 in. air tubs, each rated at 33,000 cfm.

The turbo-blowers operate on 400-psi steam, and are equipped with surface condensers. The blowing engines operate on 150-psi steam and have atmospheric condensers.

The air blast mains of all of these blowing units are cross-connected and valved to permit use on various furnaces, providing flexibility and standby protection. Normally, one small turbo-blower and one blowing engine are used on the bessemer converters.

Four two-pass, side-combustion hot blast stoves heat the blast for each furnace. Stove details are given in Table IV. Most of the stoves have conventional basket-weave checkerwork, with a few using patented designs. Stove burners are, for the most part, of pressure proportioning type of 15,000-cfm capacity, with a few of older design. The stoves normally operate five to six hours on gas and two hours on blast, consuming 25 to 30 per cent of the gas made by the furnaces. Stack temperature of the stoves ranges 200 to 350 F. Blast temperatures average 1050 to 1100 F and blast pressure, 15 to 18 psi. Blast temperatures are automatically controlled by mixer valves on No. 1, 3, 4 and 5 furnaces.

Since March, 1941, No. 1 furnace has operated on air-conditioned blast, with the moisture content of the air held to about 2.85 gr per cu ft.

Top gas temperatures normally run 250 to 450 F, and top pressures 15 to 40 oz per sq in. All furnaces are equipped with conventional dust catchers 30 ft in diameter. Two furnaces also have secondary dust catchers of the same size.

Gas for stove consumption only is wet-washed in three 50,000-cfm tower washers and fine-cleaned in 40,000-cfm rotary disintegrators to 0.008-0.025 grains of dust per cu ft. Part of the surplus gas for boilers is dry cleaned in four 95,000-cfm cyclone type vortex cleaners. A small amount of gas is wet-washed in a 10,000-cfm stationary disintegrator tower washer for use at the soaking pits.

Water from the gas washers and disintegrators flows to two thickening tanks, 105 ft in diameter, each capable of handling 8000 gpm. Sludge from these tanks is pumped to two disc type filters, dewatered, and discharged into the sintering plant bins.

Sintering facilities consist of four continuous traveling grate machines, 42 in. wide × 70 ft 8 in. long, with seven wind boxes and a 60,000-cfm suction fan. Each machine has a daily capacity of 450 net tons of sinter. Materials agglomerated on these machines include ore fines, flue dust, filtered sludge and fine coke breeze.

Bessemer and low-manganese basic irons are produced in approximate proportions of 40 and 60 per cent, respectively. Iron specifications are as follows:

	Bessemer iron	Low-manganese basic iron
Silicon	1.10-1.40	1.10-1.40
Sulphur	0.032 max	0.040 max
Phosphorus	0.085 max	0.150 max
Manganese	0.40-0.50	0.40-0.50

Each furnace makes five casts in 24 hours into mixer type ladles of 175 and 196 tons capacity. Normally, no iron is pigged, although three double-strand pig machines of 140 tons per hr total capacity are available.

Slag from the furnaces varies from 1000 to 1200 lb per ton of iron, depending on furnace practice. Slag analyses average as follows:

	Per cent	
	Bessemer	Basic
SiO_2	37.79	37.66
Al_2O_3	10.79	10.95
CaO	42.24	42.71
MgO	8.14	7.88
S	1.45	1.44

All of the slag is flushed into cinder pots and moved to a slag dump north of the plant, where it is dumped and allowed to solidify and cool. Part is then processed by a commercial slag company, the balance discarded in a slag fill.

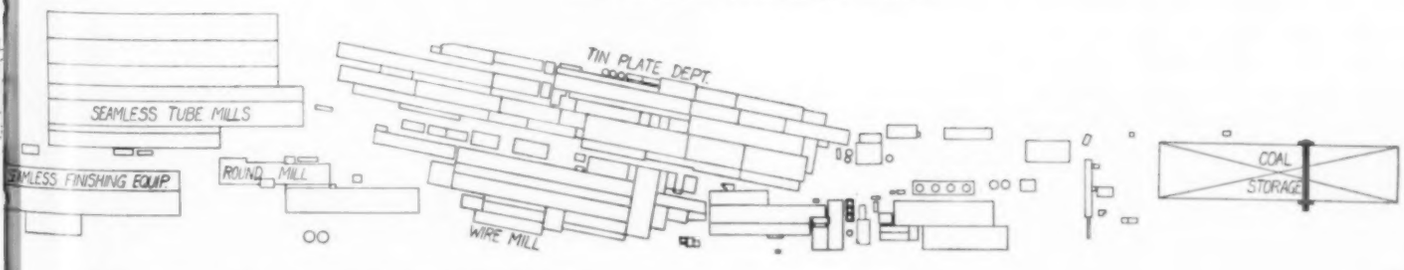
STEELMAKING

Steelmaking at Aliquippa differs somewhat from the majority of American plants in that a variety of processes is used. Three acid bessemer converters and five open hearth furnaces are used separately or in combination, and provide a total capacity of 1,764,000 net tons of ingots per year. The converters are used to produce regular bessemer steel and to blow metal for duplexing in the open hearths.

The converting mill is housed in a building 461 ft × 74½ ft, served by two 75/25 ton cranes and one 50/15 ton crane. The three converters are rated as 25-ton units. Their shells are 34 ft 3⅛ in. high and 13 ft in diameter. Each vessel bottom contains 35 tuyeres, each tuyere having seven ⅝-in. diameter holes. Two are tilted by hydraulic power, one by electric motor. Blast is supplied to the vessels by one small turbo-blower and one blowing engine, as mentioned in the previous discussion of blast furnaces.

Each converter takes a maximum charge of 62,000 lb of molten iron to turn out 54,000 lb of product. Iron

General plan of Aliquippa Works.



Three bessemer converters housed in the building in the center of this photograph turn out bessemer steel and blown metal for duplexing in the open hearth furnaces.

comes from the blast furnaces in mixer type ladles, from which a sufficient quantity is poured into a transfer ladle to charge one converter. This ladle is hoisted by crane and emptied into a tilted converter. The blast is turned on and the converter raised to an upright position. Scrap, which acts as a coolant, is also charged to an extent of 3000 to 9000 lb, depending on the silicon content of the iron and other factors.

As the blow progresses, the metalloids are oxidized — first silicon, then manganese and carbon. Oxidation of silicon is the principal source of heat. The early portion of the blow is characterized by a short flame and heavy fumes, and as greater amounts of carbon oxidize to CO, the flame lengthens and becomes more luminous as the CO changes to CO_2. The end of the blow is indicated by a momentary halt in the flame drop, called the end point. The vessel is then turned down to avoid excessive oxidation of the iron.

Blast to the vessel is generally about 30,000 cfm, at approximately 25 psi pressure, and the blowing time normally ranges 10 to 15 minutes, depending on blast volume and silicon content of the iron. The photoelectric cell method of bessemer flame control, as developed by the company, is used on all blows.

After the heat is turned down, the blown metal is poured into a bessemer teeming ladle or into an open hearth charging ladle, depending on the product. The slag remaining in the converter is then dumped into a cinder pan beneath the vessel.

Two types of iron are used in the converters. (See "Blast Furnaces" for analyses). For the production of bessemer ingots, bessemer grade iron is used, while the low-manganese basic iron is used for the production of blown metal for the open hearths.

The blown metals poured from the converters show analyses as follows:

	Bessemer metal	Basic blown metal
Carbon	0.03-0.04	0.04-0.50
Manganese	0.03-0.04	0.03-0.04
Silicon	0.01 or less	0.01 or less
Phosphorus	0.065-0.075	0.12-0.18
Sulphur	0.04 max	0.04 max

The phosphorus and sulphur contents of these metals are about the same as in the original iron, since neither are removed in the acid bessemer process. Converter slag analyses run about as follows:

	Per cent
FeO	15-20
SiO_2	55-65
MnO	8-12
CaO	0.5
MgO	0.2
Al_2O_3	5.
TiO_2	3.

Ferro-alloy additions to bring bessemer heats to the desired final analysis are made either to the converter during the blow or to the ladle before pouring. Ferrophosphorus, copper and sulphur are added during the blow, while the oxidizable elements, such as manganese, aluminum, silicon, and coal, are added in the ladle.

Bessemer heats are transferred by motor-driven transfer buggies from the converter building to the teeming building, where the ladles are handled by a 50-ton crane for teeming. The pouring platform is equipped for producing leaded steel, having a 12,000-lb lead dust storage hopper, a 1200-lb lead feeding tank, a remotely controlled lead feeder, a lead addition gun, a fume collecting buggy and, in an adjacent area, a bag filter installation for fume cleaning.

Bessemer steel production has been averaging about 40,500 net tons per month, of which about 90 per cent is capped and keyed, 7 per cent hot-topped, and 3 per cent rimmed.

In addition, about 83,600 tons of blown metal is produced for the open hearth. This is transferred to the open hearth in 25-ton ladles mounted on buggies which are moved by a diesel-electric hot-metal engine.

Since converter shells must be relined every 400 to 700 heats, and heats are turned out rapidly, maintenance is a rather steady operation. The vessel to be relined is moved from its operating pedestal and placed in a relining stand. The old lining may be completely torn out, or only the shoulder and nose portions may be removed. The new lining, which consists of mica schist stone and a mortar of ganister mud, is dried with a fuel oil flame. Full linings require 12 to 14 hours drying time, patch linings 6 to 8 hours. Three spare shells permit continuous operation while maintenance is carried on.

The life of converter bottoms usually runs 45 to 50 heats, although some run higher. In one case, 101 heats were blown on a single bottom, which is believed to be a world record. After a bottom has been put into service, the wind box cover is removed once or twice each 8-hour turn to inspect the tuyeres. Tuyeres that have burned out are blanked off.

When the length of the tuyeres decreases from the original 34 in. to 16 in. or less, or when the bottom leaks and cannot be repaired, the bottom is replaced, the

Here one converter may be seen blowing a heat, while, at the bottom, hot metal is being reladled to charge another converter.

Because of the variety of types and grades of steel produced at Aliquippa, numerous sizes and types of ingot molds are used.

change requiring one to two hours. Jack cars remove the old bottom, transport it to the bottom house, and force the new bottom into place on the converter.

In the bottom house are storage bins for the various stones and clays used in converter and ladle maintenance. Two mud pans prepare the necessary mixes and mortars. The old material is removed from the bottom shell and the 35 new tuyeres are inserted. A mud mix is then poured in and about 80 bottom tile placed between the tuyeres. The reconstructed bottom is then placed in one of eight gas-fired ovens and dried at 400 to 500 F for a minimum of 48 hours. New bottoms are available at all times to be placed into service as needed.

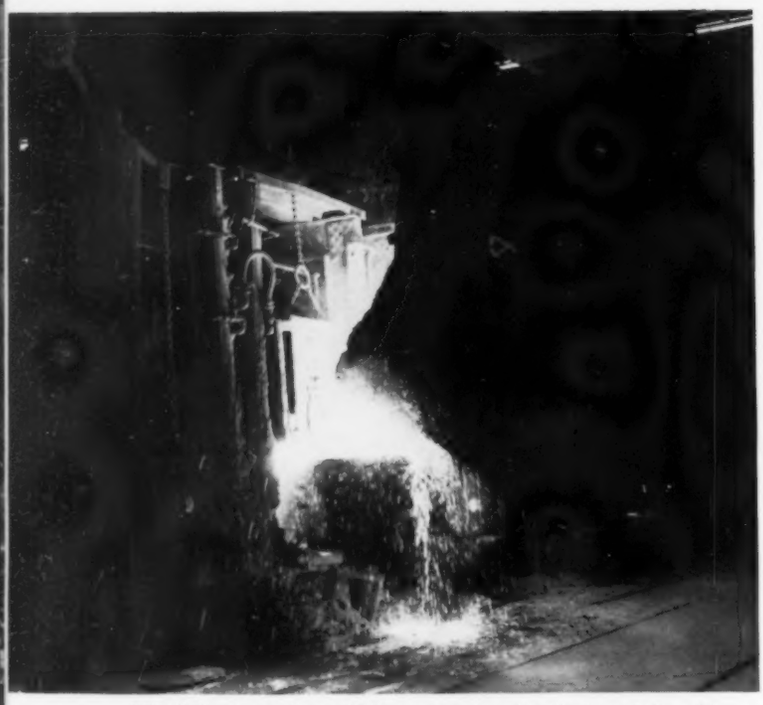
Open hearth steel is produced by the duplex process, by the scrap and hot metal process or by a combination of the two. The original installation in 1912 consisted of four tilting furnaces, which are particularly adapted to the duplex process. In 1937 one additional furnace of stationary design was built. This furnace uses the scrap and hot metal process exclusively.

The four tilting furnaces, built on 110-ft centers, are 90 ft long inside the buckstays × 22 ft wide. Bath dimensions at the foreplate level are 44 to 49 ft long × 16 ft wide, giving hearth areas of 704 to 784 sq ft. The stationary furnace is 70 ft 6 in. long × 23 ft wide, with a bath 44 ft long × 17 ft 4 in. wide, giving 728 sq ft area.

Furnace bottoms are about 36 in. thick, built up of 4 in. of insulating material and 14 in. of brick, variously topped with burned magnesite or a ramming mix and burned magnesite.

Furnace roofs are 15 in. thick with 18-in. ribs. Zebra courses of basic brick are used along the back skewbacks. Basic brick front walls are used in all furnaces, and basic brick panels are installed in the port ends. The stationary furnace has suspended basic ends.

The tilting furnaces are supported on rockers and are tilted on rollers by motor-operated screw mechanisms.



All of the open hearth furnaces employ hot metal or blown metal in varying proportions in their charges.

Double slag pockets are incorporated in the tilting furnaces, single pockets in the stationary furnace.

All furnaces have double regenerator chambers at each end. The smaller chamber is 7 ft 9½ in. wide, the larger, 12 ft 10 in. wide. Both are 21 ft long, and contain checkerwork 14 ft 9½ in. deep.

Oil is the principal fuel, but the two end furnaces also use some coke oven gas and natural gas. For the entire shop, fuel consists of about 80 per cent oil, 20 per cent gas.

Fuel oil is received chiefly by river barge, but truck and tank car shipments can also be handled. As received, it is pumped into two 2,100,000-gal storage tanks which are protected by foamite systems.

From the storage tanks, fuel oil is pumped through a circulating system at 175 psi pressure, 135 to 140 F temperature. At each furnace, an individual heater raises oil temperature to about 190 F. Water-cooled artillery type burners are used, with single barreled units on the three oil-burning furnaces and double-barreled burners on the furnaces which use oil and gas.

All of the furnaces have automatic reversal equipment, based on temperature differential. Also, all furnaces have roof temperature recorders, oil meters, and radiation pyrometers for bath temperature. Four of the furnaces are equipped with 18,000-cfm forced draft fans.

Typical experience will find the open hearth turning out about 110,000 net tons of ingots per month, of which about 86 per cent will be by duplex process, 12.5 per cent by scrap and hot metal, and 1.5 by the mixed process (a combination of the other two).

For duplexing, the furnace charge consists of burned lime, limestone, roll scale, blown metal and molten iron. About 85 per cent of the charge is blown metal and 13 per cent hot iron. For scrap and hot metal heats, a charge of limestone, 60 per cent scrap and 40 per cent hot metal is used. In mixed practice, the charge is a mixture of scrap, blown metal and hot iron, preceded by a flux. In a month of full production, the open hearth will use about 36,000 tons of molten iron direct from the blast furnaces, 84,000 tons of blown metal from the converters, and 6000 tons of scrap.

Heats of 152 tons are tapped, with heat times averaging 4 hr 6 min for the duplex process and 10 hr 28 min for the scrap-hot metal process. Production rates are 39 and 15 tons per furnace-hour, respectively, for the two processes, and fuel consumption 1,693,000 and 4,171,000 Btu per ton of steel produced.

An unusually wide variety of types and grades of steel is made, as evidenced by typical performance records showing 64 per cent of the production as killed steel, 14 per cent as fine grain steel, 10 per cent rimmed, 5 per cent rim and jar, 4 per cent silicon capped and 3 per cent capped and keyed. To further complicate the picture, open hearth steel is produced in analyses showing the following ranges:

	Per cent
Carbon	0.05-1.05
Manganese	0.18-2.65
Phosphorus	Up to 0.15
Sulphur	Up to 0.33
Silicon	Up to 0.35
Chromium	0.60-0.80
Molybdenum	Up to 0.35
Vanadium	0.05-0.20
Copper	Up to 0.35
Aluminum	Up to 0.05
Nitrogen	Up to 0.015
Boron	0.002-0.003
Zirconium	0.10-0.20
Titanium	0.01-0.05
Lead	0.15-0.35

With the exception of one or two grades, all grades of steel can be made by any of the three open hearth processes.

The production of these various grades of steel requires the use of fluxes, deoxidizers and alloys averaging, overall, as follows:

	Lb per net ton
Burned lime	54.70
Limestone	44.07
Fluorspar	2.82
Roll scale	50.32
Ferro-silicon	2.64
Speigel	3.96
Si-Ti-Al alloy	1.67
Silico-manganese	0.18
Carbo-silicon	0.48
Ferro-manganese	24.15
Anthracite coal	0.42
Molybdenum	0.35
Copper	0.31

Smaller amounts of ferro-phosphorus, sulphur, ferro-vanadium, lead dust, etc., are also used.

Eight principal mold types are used:

22 in. × 24 in., 25 in. × 27 in., and 27 in. × 36 in. bottle tops, for capped and keyed, and silicon capped ingots.

22 in. × 24 in. big-end-down, for rimmed, semi-killed, rimmed and jarred and silicon capped ingots.

24 in. × 24 in. open top or hot top, for rimmed, semi-killed, killed and fine grain steel.

27 in. × 36 in. and 24 in. × 47 in. open top, for rimmed and semi-killed steel.

24½ in. × 24½ in. big-end-up, for killed and fine grain steel.

Molds are prepared for teeming by cooling them in water and spraying with powdered pitch and a commercial preparation. This is done in a building 440 ft × 93 ft 4 in., served by two 25-ton cranes. This building also has facilities for reconditioning and preparing hot tops.

On the tilting furnaces, slag is flushed from the front of the furnaces into cinder pots during the working of the heat, and some slag is flushed from the tapping spout while tapping the heat.

On the stationary furnace, all slag is removed at the back of the furnace during the tap.

Typical slag analyses are as follows:

	Duplex practice	Scrap—hot metal process
FeO	19.48	15.27
Fe_2O_3	7.14	6.23
SiO_2	10.70	15.22
CaO	45.98	46.80
P_2O_5	4.40	1.95
MnO	2.98	5.20
V ratio	3.81	2.92

Cinder pots from the open hearth and from the bessemer converters are transferred to a slag dock and dumped there. The slag is crushed by a skull cracker, loaded into dump cars and taken to a slag disposal plant nearby.

Two carbometer stations are provided for making rapid carbon determinations on the heats, and a chemical control laboratory on the open hearth floor makes preliminary tests on all heats.

The open hearth building is 651 ft 8 in. long × 74 ft 9 in. wide, and is served by three 50/15 ton cranes and three 10-ton charging machines. The pouring bay, of the same length but 47 ft 3 in. wide, is served by three 185/25 ton ladle cranes, and contains two pouring platforms. One platform is equipped for the production of leaded steel, while the other has a jarring unit for the production of rimmed and jarred steel.

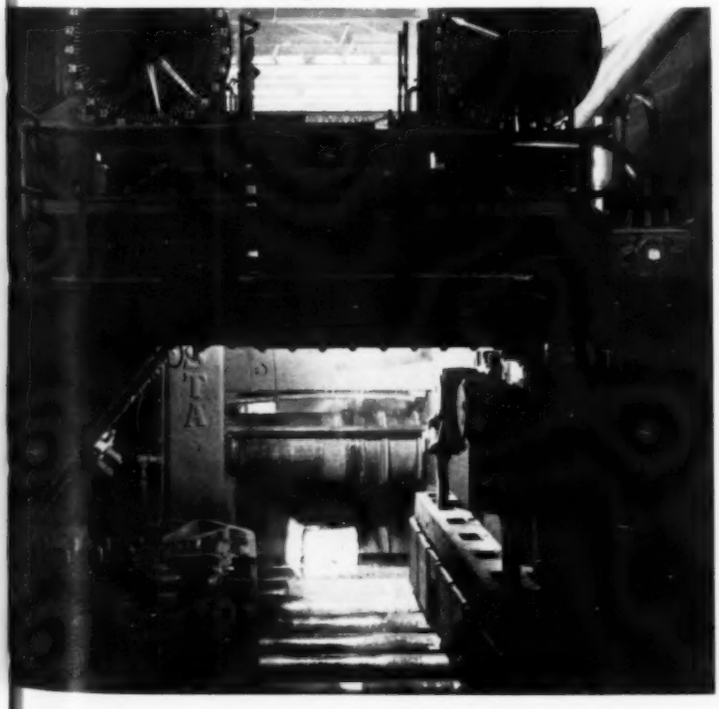
Facilities for lining open hearth ladles and for making stopper rods are conveniently located here.

Adjacent to the open hearth floor is a stockhouse 330 ft long × 73 ft 2½ in. wide, containing storage bins for limestone, burned lime, roll scale, dolomite, fluor-spar, iron ore, etc. The lower level of this building has storage bays for ferroalloys, ladle brick, etc.

Due to the nature of steelmaking processes at Aliquippa, the plant actually uses less scrap than is made in the mills. Consequently, little storage space is provided for scrap. Some scrap is shipped to the company's other plants.

There are two stripper yards. One yard, containing two 150-ton cranes, is used for stripping all open hearth ingots except big-end-up type. The second yard, with a 200-ton stripper crane, is used for all big-end-up ingots and all bessemer ingots.

The 44-in. blooming mill, modernized in 1953, has rolled 576 ingots in an eight-hour turn, producing 2543 net tons sheared weight.



BLOOMING MILL

From the strippers, drags of ingots are moved to the soaking pits, which are located in a building 518 ft 3 in. long and served by three pit cranes of 68-ft span. There are eleven rows of pits, providing a total of 44 holes. These pits vary in size, ranging 8 ft to 18 ft 2 in. in length, 5 ft 7½ in. to 6 ft 10 in. in width and 8 ft to 11 ft 6 in. in depth. They provide a total hearth area of 2779 sq ft. Pit covers are operated either by hydraulic rams or by motor-driven pinion and rack.

Ten rows of pits are of regenerative type, and are fired with coke oven gas. Each row is operated on a time reversal cycle. One row is of recuperative design, and is fired with mixed blast furnace and coke oven gas of about 165 Btu per cu ft. An 18-in. coke breeze bottom is maintained in the pits.

Normally, ingots are charged into the pits at temperatures ranging 1600 to 1800 F after about two hours track time. Heating time runs approximately five hours. Fuel consumption averages 709 Btu per ton.

An ingot ready for rolling is drawn by pit crane and placed in an ingot buggy which carries it to the mill table at speeds up to 1700 fpm. The approach table is 45 ft long and contains a scale which records ingot weight.

The blooming mill and its drive were installed in 1953, replacing a steam-engine driven mill that set many production records during its time. The changeover was accomplished in the remarkable time of 7 days and 14½ hours down-time.

The new mill is a 44-in., two-high reversing unit, with cast alloy steel rolls of 43-in. collar diameter and 90½-in. body length running in babbitted bearings. The rolls carry passes of 8 in. and 12 in., and a 59⅜ in. bullhead. The top roll is hydraulically balanced and is moved up and down by 12-in. mill screws of 2-in. pitch, single thread. The screwdown mechanism is driven by two 150-hp, 400 to 1200 rpm, mill type motors operating under adjustable voltage control. Roll lift speed ranges up to 50 fpm, and maximum opening is 44½ in.

The mill is driven by four 3000-hp, 70 to 140 rpm,

750-volt, d-c, double-armature motors, arranged in tandem twin drive. Two motors drive each roll through a 21-in. diameter spindle 19 ft 7 in. long. The drive has a rated full-load torque of 2,020,000 ft-lb at 80 rpm.

Main drive motors draw power from a motor-generator set consisting of four 3000-kw, 750-volt, d-c generators, a 15 ft 10 in. diameter, 220,000-lb steel plate flywheel, and a 9000-hp, 6600-volt, 360-rpm induction motor. The flywheel has 250,000 hp-sec stored energy at 360 rpm. Normally, two generators and two drive motors are connected in parallel on a separate bus, but if one generator is out of service, the remaining three generators are connected on a common bus to serve all four drive motors.

Rotating regulators are used to divide the load equally between the four drive motors. The regulating system of the drive affords rapid mill reversal — slightly less than one second from 70 rpm in one direction to 70 rpm in the other direction, and about 2½ seconds from 125 rpm to 125 rpm.

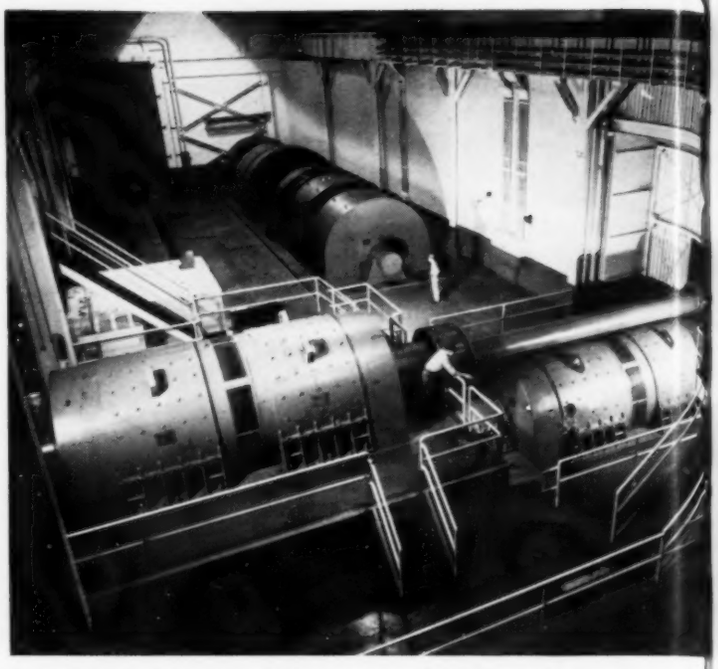
Adjustable voltage auxiliary drives draw power from special motor-generator sets, with a 300-kw, 250/500-volt generator for each mill table section, a 40-kw, 165/330-volt generator for each of the feed rollers, and two 150-kw, 250/600-volt generators for the screwdown motors.

Power consumption for the main drive and auxiliaries averages 14.5 kwhr per net ton of product.

Main drive motors, motor-generator sets, controls and switchgear are housed in a motor room, 191 ft 6 in. × 68 ft 6 in., provided with a down-draft recirculating ventilating system. Recirculated air is passed through metallic ribbon type filters and surface type coolers. Make-up air is washed, filtered and put through an electrostatic precipitator.

In the mill, the ingot is handled by overhead manipulators actuated by a 600-psi water system composed of three turbine-driven pumps and a weighted cylindrical accumulator. Sideguards are driven by two 16-in. cylinders at speeds up to 138 fpm. Hydraulic-powered fingers on the delivery side of the mill turn the ingot as desired. This equipment served the old mill, and was not replaced when the new mill was installed.

Mill tables on both sides of the mill are 47 ft 3 in. long, and are each driven by two 125-hp mill type



This electric drive, consisting of four 3000-hp motors, was installed on the 44-in. blooming mill in 1953, replacing a steam engine.

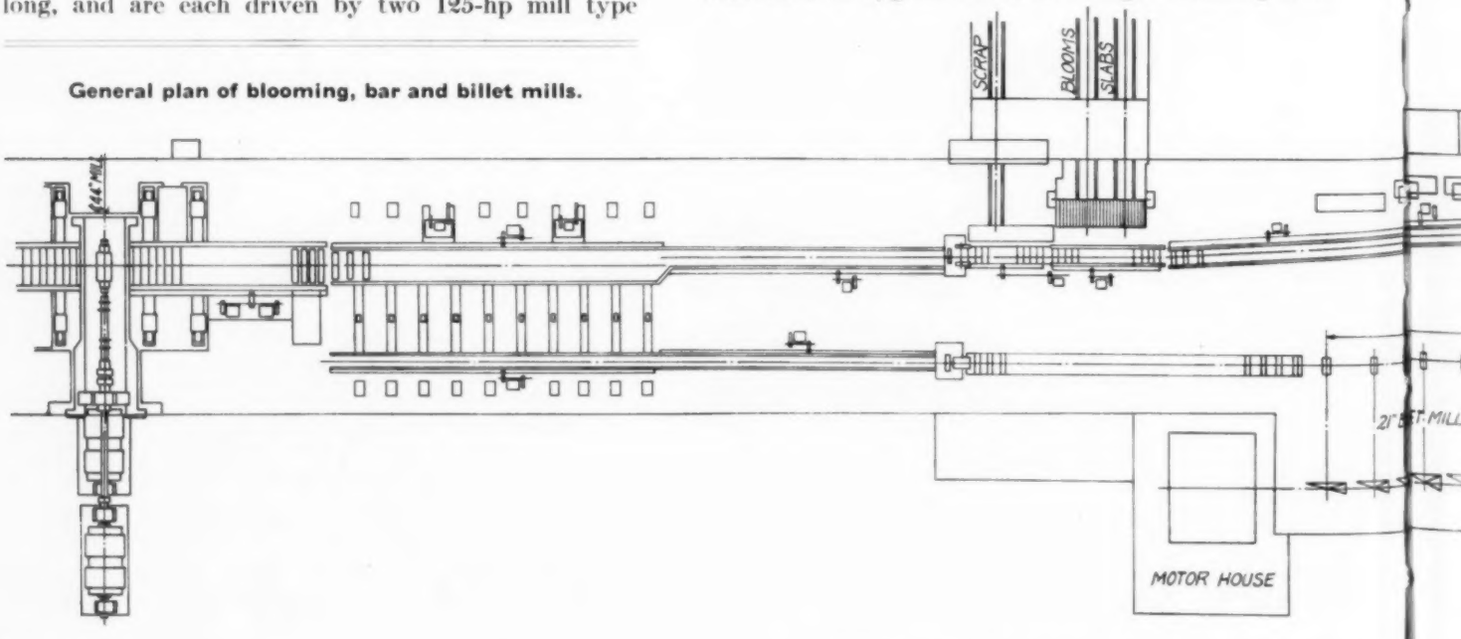
motors. Two feed rollers on each side of the mill are individually driven by 75-hp motors. All of these drives operate under adjustable voltage control, and table speeds up to 665 fpm are available.

The entire mill is lubricated by three automatic grease systems which serve 152 points; one circulating oil system of 15 gpm, 300-gal storage capacity, serving 12 points on the screwdown; one circulating oil system of 200-gal storage capacity, serving the mill drive motors and motor-generator set; and two 300-gal oil bath systems serving the mill tables. Numerous points also require manual lubrication.

Scale falling through the tables is moved by vibrating chutes into a pit box which is emptied by crane into a hopper car.

The blooming mill is designed to roll square blooms ranging from 7 in. to 12⅝ in., and slabs 25 to 42 in. wide × 4 to 7½ in. thick, from ingots running from

General plan of blooming, bar and billet mills.



22 in. × 24 in. (9000 lb) up to 24 in. × 47 in. (23,500 lb).

The mill rolls at speeds up to 1350 fpm, and averages about 225 net tons per hour. The mill has rolled as much as 335 tons per hr, 2562 tons per 8-hr turn, 6200 tons per day and 164,532 tons per month.

Steel leaving the mill may follow one of three paths. Blooms or slabs for outside shipment or for seamless pipe production move straight ahead to a hydraulic shear capable of cutting sections up to 224 sq in., located 212 ft beyond the mill. Leaving the shear, these products are pushed off the table on to a buggy, which is then pulled up a ramp by cable and winch into the slab yard. Here, slabs are cooled, conditioned by hand torches, and loaded for shipment. Blooms for seamless pipe are loaded hot into rack type cars or insulated cars designed for slow cooling of alloy grades.

Blooms intended to be rolled down into slab billets or skelp on the 18-in. bar and skelp mill proceed from the shear straight ahead to the first stand of this mill, some 270 ft from the shear.

Blooms to be further rolled into billets are removed from the blooming mill line ahead of the shear previously mentioned. They are moved over a 23 ft 9 in. transfer to a parallel mill line which carries them to a motor-driven shear designed to cut a 64-sq in. section, and then on to the first stand of the 21-in. billet mill, about 93 ft beyond the shear.

Crop ends from both blooming mill shears fall through chutes into a common scrap box placed on a buggy at the bottom of a ramp. This buggy is pulled up the ramp by cable and winch, and the scrap is dumped by crane. After cooling, the crops are loaded into gondola cars by magnet and crane.

BAR AND BILLET MILLS

The 18-in. bar and skelp mill is a two-high continuous mill with a roughing train of four 21-in. stands and two 18-in. stands, and, following a looping pit, a finishing train of six 18-in. stands and two vertical edgers. All horizontal stands use adjustable side-guard entry guides, and top and bottom stripper type delivery guides.

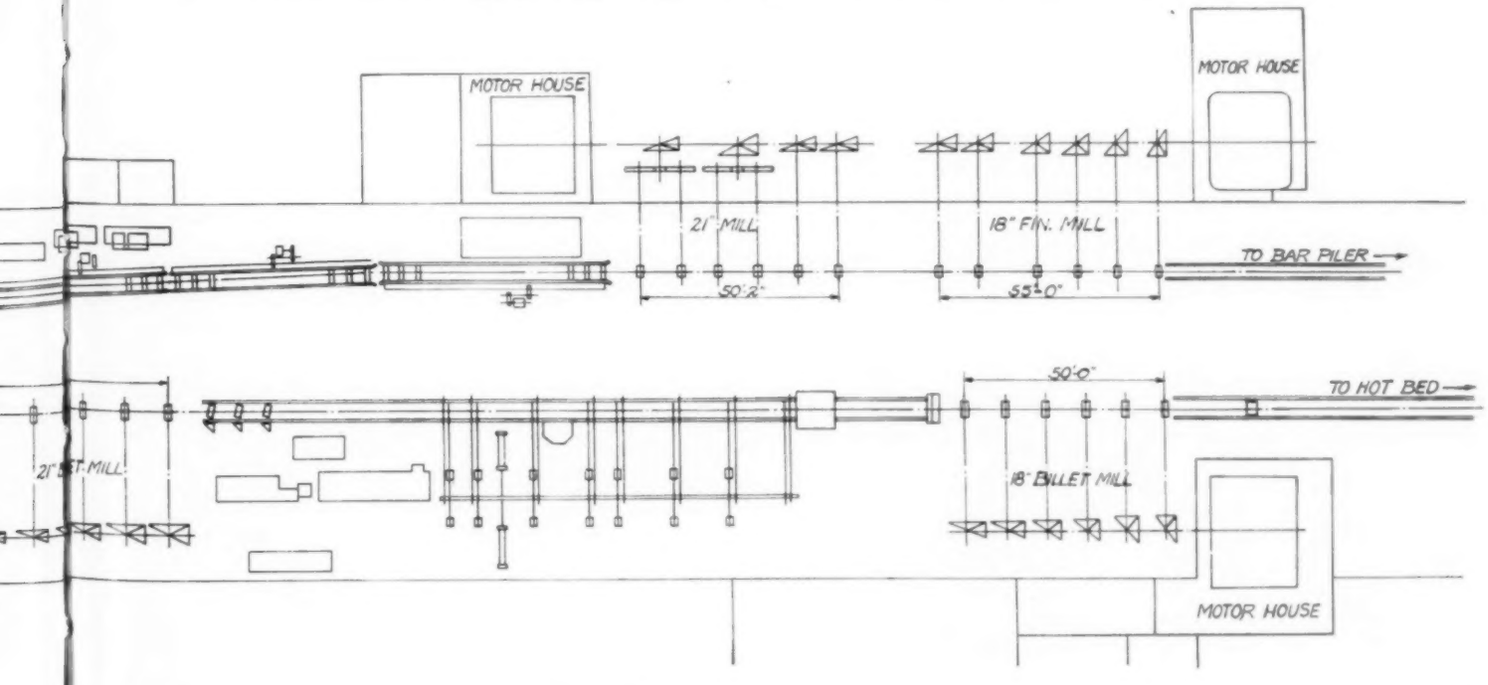
Each train is driven through gearing and pinions by a 5750-hp, 92.5-rpm, 6900-volt, 25-cycle induction motor. Stand spacing and speeds are as shown in Table V. The mill has a maximum delivery speed of 585 fpm.

This mill takes blooms, direct from the blooming mill, ranging 7⅞ to 14⅞ in. wide × 4 to 8 in. thick, and reduces them to slab billets 7¼ to 15 in. wide × 1⅞ to 4¾ in. thick, or to skelp of 9¼ to 15⅜ in. width and 0.196 to 0.304 in. thickness. These products are

TABLE V

Bar-Skelp and Billet Mills

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Roll rpm
	Maximum diameter	Body		
21 — 18-in. Bar and Skelp Mill				
No. 1	18½	25	.....	9.16
No. 2	18⅞	25	10-3 5/16	11.0
No. 3	20⅝	25	9-3	12.52
No. 4	20 11/16	25	10-3⅛	16.49
No. 5	17⅜	20	10-2 11/16	23.9
No. 6	17¼	20	10-0	31.2
Edger	12½	..	20-9.21	38.58
No. 7	17⅝	20	4-8.79	36.04
No. 8	18⅜	20	10-0	44.8
Edger	12¼	..	4-8.285	73.32
No. 9	18	20	10-3.715	61.66
No. 10	19	20	10-0	76.49
No. 11	18	20	10-0	102.34
No. 12	18	20	10-0	123.34
21 — 18-in. Billet Mill				
No. 1	21½	48	.....	15.081
No. 2	21 5/16	48	12-7	18.074
No. 3	21⅛	48	12-0	20.676
No. 4	21⅜	48	12-0	27.407
No. 5	21½	48	12-0	32.435
No. 6	21½	48	11-0	43.082
Edger	16	..	195-3.21	38.576
No. 1	18-20	27	4-8.79	36.039
No. 2	18¾	27	10-0	44.804
No. 3	18	27	10-0	61.666
No. 4	19	27	10-0	76.490
No. 5	18⅛	27	10-0	102.340
No. 6	19	27	10-0	123.333



finished out of various stands of the mill, as best fits the rolling schedule. Products go principally to the 14-in. merchant mill, to the welded tube mills or to direct shipment.

This mill has a rated capacity of 35,000 tons per month, but it is rarely operated at capacity. Its production depends on the distribution of steel from the blooming mill.

Skelp is cut to length by a steam-driven flying shear located 22 ft beyond the mill and capable of cutting up to 16-sq in. sections. Slab billets are cut to length on an up-cut shear of 72-sq in. capacity, placed 83 ft beyond the mill.

Sheared product is carried on the runout table to a hydraulic bar piler located in one of two billet yards. Piled product is carried by spider hook and crane to one of three cooling beds. After cooling, product is loaded into railroad cars for shipment or moved to a conditioning area in the billet yard.

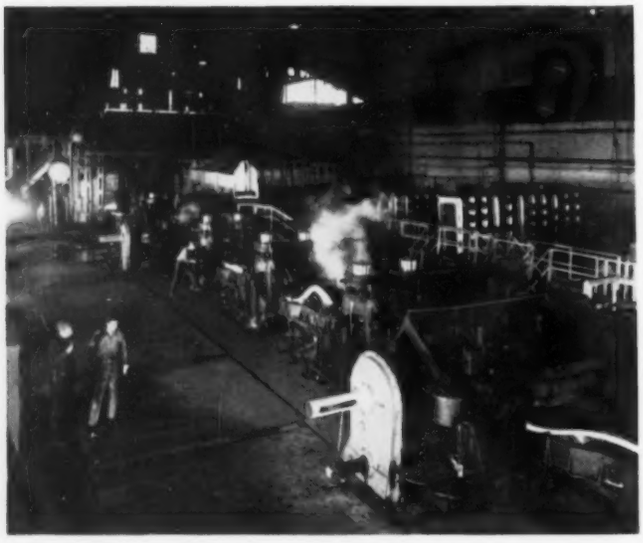
The billet mill, which parallels the bar-skelp mill at a distance of about 35 ft, is also a two-high continuous unit consisting of six 21-in. roughing stands and, about 200 ft away, six 18-in. finishing stands preceded by a vertical edger.

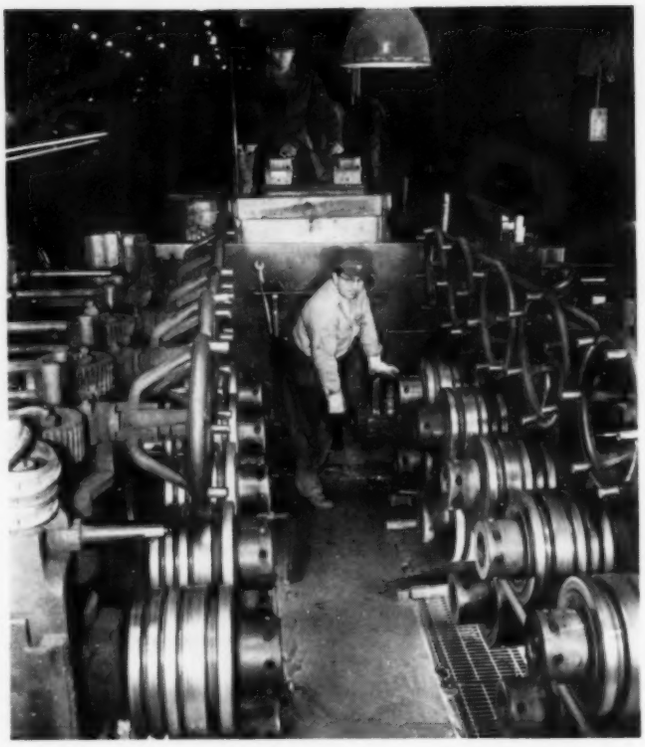
Each train is driven through gearing and pinions by a 5750-hp, 92.5-rpm motor duplicating those on the bar-skelp mill. The finishing train motor also drives a crop shear preceding the train, as well as the vertical edger. Mill speeds and stand spacing are given in Table V. The mill has a maximum delivery speed of about 575 fpm.

The billet mill receives only 8-in. square blooms from the 44-in. mill, and reduces them to billets ranging from $1\frac{3}{4}$ in. squares up to $6\frac{5}{8}$ in. $\times$ 5 in. Billets smaller than 4 in. square are finished in the 18-in. train and sheared to length on a steam-operated flying shear. Billets 4 in. square or larger are finished in the 21-in. train, sheared on a 42-sq in. capacity up-cut shear, and dummied through the 18-in. train.

Roughing stands of the billet mill use box pass alloy steel rolls, running in babbitted bearings. Entry guides are of adjustable side guard type. Stands No. 1, 3 and 5 have roller twist delivery guides which twist the product 90 degrees, while stands No. 2, 4 and 6 use top and bottom box type delivery guides.

The 14-in. merchant mill rolls a wide range of sections and has a maximum delivery speed of 3300 fpm.





This straightener is the final operation on the 14-in. merchant mill when rolling structural shapes.

Billets to be finished on the 18-in. mill are cropped and then moved backward on the skew runout table, dropping into roller grooves for entry into the finishing stands in diamond position. The 18-in. stands use diamond passes in grain alloy iron rolls running in composition bearings. The guide setup on the 18-in. stands is similar to that of the 21-in. train, with roller twist delivery guides on stands No. 1, 3 and 5.

Finished billets are conveyed by roller table to one of three hot beds, where they are hand-stamped for identification and pushed off into cradles for loading by crane into rack type cars.

The billet mill has a rated capacity of 75,000 net tons per month.

MERCHANT MILL

The Aliquippa 14-in. merchant mill was erected in 1924 to the company's own design, primarily to produce junior beams but also capable of rolling angles, channels, flats, etc.

Billets 21 ft to 29 ft 6 in. long are heated in a continuous side-charged, side-discharged furnace with a hearth 31 ft wide $\times$ 52 ft long. Two furnace skid tables serving the furnace extend into two adjacent billet yards, 277 ft $\times$ 78 ft and 225 ft $\times$ 84 ft, respectively. A conveyor moves billets to the furnace.

This furnace is fired with coke oven gas, and is equipped with automatic controls on fuel-air ratio and furnace pressure. It consumes 1,983,000 Btu per ton of steel.

As the heated billet is removed from the furnace by pushout ram and ejector pinch rolls, it passes through a shear where it may be cropped or divided as desired.

TABLE VI

14-In. Merchant Mill

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm
	Maximum diameter	Body length					
No. 1	15	30	.....	3000	200/300	7.72	25.9/46.7
No. 2	15¾	30	5-11.737			5.78	34.6/62.3
No. 3	16½	30	5-11.366			4.0	50/90
No. 4 (Edger)	18	22	11-0¾	750	360/860	7.23	49.7/118.8
No. 5	15½	20-30	15-0	1700	90/205	Direct	90/205
No. 6	15½	20-30	16-6	1700	90/205	Direct	90/205
No. 7	15½	20-30	16-0	2100	150/460	Direct	150/460
No. 8 (Edger)	18¾	22	11-0	200	360/860	2.55	140.8/336.5
No. 9	16	20-30	15-0	2100	150/460	Direct	150/460
No. 10 (Edger)	18¾	22	11-0	200	360/860	2.55	140.8/336.5
No. 11	16	20	15-0	2000	210/680	Direct	210/680
No. 12	16	20	15-0	2000	260/800	Direct	260/800
No. 13	31¾	17	8-7.408			3.97	65.5/201.6

The mill is a straight-away continuous mill of 12 stands, with a 13th stand replacing No. 12 when junior beams are being rolled. The first three stands, which are driven through gearing by one motor, are 16-in. roughers. Stands No. 4, 8 and 10 are bottom-driven vertical edgers. The remaining stands, individually driven, are 14-in. units, but in some cases, 16-in. pinions and larger rolls are used on No. 9 and 12 stands. It is planned to change to 18-in. pinions on the first three stands and 16-in. pinions on the other stands in the future, as this mill is called on to roll some oversize sections.

When rolling junior beams, No. 12 stand is removed, and another stand, No. 13, is put in. This stand has 29-in. pinions and large horizontal rolls, driven through gears by the regular No. 12 drive, and also 18-in. vertical idler rolls.

Table VI gives data on the mill layout and speeds. It should be mentioned that the roll diameters given in this table are typical for flat products, and may be somewhat different for other types of product.

The first two horizontal stands and all three edgers have babbitted bearings, while all other stands use composition bearings. Roller bearings have been applied in the mill drives. All stands are provided with motor-operated screwdowns.

Scale is removed from the steel by hydraulic sprays at No. 1, 2 and 3 stands. Water at 1000-psi pressure is supplied by a motor-driven 1000-gpm centrifugal pump.

The 14-in. mill takes billets 2⅝ to 15 in. in width and 2⅝ to 5 in. in thickness. It rolls 6, 8, 10 and 12-in. junior channels, 10 and 12-in. special channels, and 3, 4, 5 and 6-in. standard channels. Flat rolled material is produced ranging 1½ to 15 in. wide and ⅜ to 2⅝ in. thick, with the limitations of thickness being not greater than half of the width and in the lighter gages of ⅜ to ⅝ in., the minimum width is 2 in. Angles are rolled in open passes in sizes of 1½ to 6 in. in equal leg sections and from 1¾ in. × 1½ in. up to 6 in. × 4 in. in unequal leg sections.

The foregoing sections are produced regularly in standard gages. In addition, many special sections, such as junior beams, hinge sections, rim sections, etc., are made on this mill. Because most of the sections rolled on this mill are made in open passes, guides are very important and must be designed for quick, accurate adjustment and rigid stability.

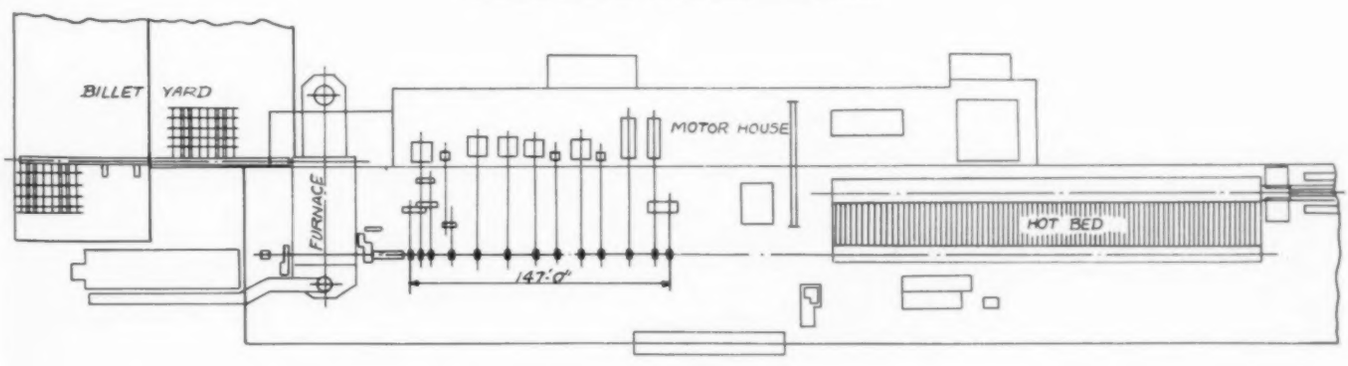
Rolling rates average 40 tons per hr, with records of 735 tons in an 8-hour turn and 31,978 tons in one month.

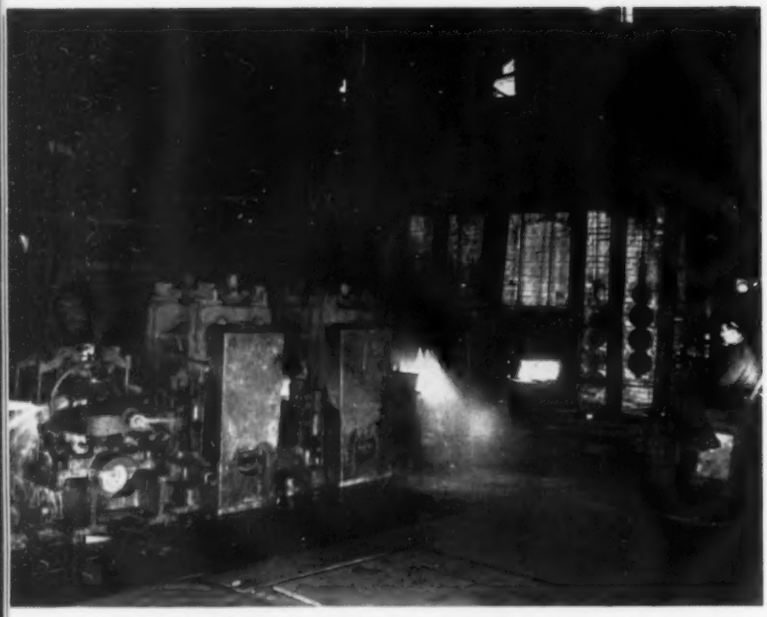
The mill has a maximum delivery speed of 3300 fpm out of No. 12 stand, quite fast for a mill of this type at the time of its construction. When No. 13 stand is used, a maximum delivery speed of 1670 fpm is available.

Material leaving the mill is delivered over a 300-ft runout table containing 64 individually driven rollers, and is kicked off on to a 250 ft 6 in. walking beam hot bed. Next, all product except flats over 6 in. wide are straightened by two roller units in the hot bed runout.

Straightened product is accumulated for multiple shearing or sawing on two combination units. Sheared product is moved to a bar piler which deposits the piles

General plan of 14-in. merchant mill.





The 10-in. skelp mill, an eleven-stand continuous unit, produces skelp which is used principally for making welded tube.

on skids for overhead crane handling to a scale and to storage. Overhead cranes also load products into railroad cars or trucks for shipment.

The main mill building, which houses the furnace, roll train, hot bed, straighteners and other auxiliary equipment, is 894 ft 8 in. long × 100 ft 4 in. wide, and is served by two 20/5-ton cranes and one 10-ton crane. The mill also uses 20,000 sq ft of space in another building for slitting junior beams into tee-bars and for reshearing and straightening rim sections.

10-IN. SKELP MILL

Skelp for the production of welded pipe comes from the 18-in. mill previously described, and from a 10-in. skelp mill designed to roll billets ranging 1¾ to 8 in. in width and 1¾ to 3⅛ in. in thickness into skelp 1⅝ to 8 5/16 in. wide and 0.072 to 0.235 in. thick. The 10-in. mill also produces some strip.

This unit is installed near the billet yards serving the two 18-in. mills, and its furnace charging skids extend into the billet yards. Thus, steel rolled on either of the 18-in. mills may be placed on these skids directly from the billet storage.

The furnace serving this mill is a continuous, side-charged, side-discharged unit, 32 ft 5 in. × 25 ft, fired with coke oven gas. The heated billet is pushed from the furnace directly into the mill, which is located very close to the furnace.

The mill is a continuous train made up of five 12-in. stands, three 10-in. stands and three vertical edgers. Table VII gives some details of this mill. The five 12-in. stands and the first edger are driven through gearing by a 1300/2000-hp, 65 to 115.4-rpm, 6600-volt a-c motor. The three 10-in. stands are driven through belts by a 2000-hp, 160 to 250 rpm, 6600-volt a-c motor. The second edger is driven by a 167-hp, 250 to 450-rpm motor and the third edger by a 50-hp, 200 to 800-rpm motor. A looping pit is provided before and after the second edger.

Babbitted bearings are applied on the roll necks of the first three horizontal stands and the first two edgers. All other horizontal stands use composition bearings. The third edger is equipped with roller bearings.

Normal rolling practice has reductions of 25 to 35 per cent in each roughing stand and 18 to 25 per cent in each finishing stand. Box type entry guides and double plate type delivery guides are located at each stand.

Skelp leaves the mill at speeds up to 1380 fpm and is sheared to desired lengths by a belt driven rotary shear. The product is conveyed to two hot beds 35 ft × 20 ft and finally discharged on a hydraulic bar piler. Piles are then moved by crane to cooling skids.

The 10-in. skelp mill has a rated capacity of 25,000 tons per month, but has rolled as much as 555 tons in an 8-hr turn, 1503 tons in one day and 34,352 tons in a month.

WELDED TUBE DEPARTMENT

The welded tube department at Aliquippa consists of one lap weld mill and two butt weld mills, with the necessary pipe finishing equipment. These three mills can produce 2 to 4 in. lap weld pipe and ½ to 3 in. butt weld pipe to a rated annual finished pipe capacity of 120,000 tons and 190,000 tons, respectively, for the two types.

The department receives lengths of low carbon skelp 17 to 22 ft long, delivered in railroad cars, from the 10-in. skelp mill, the 18-in. bar-skelp mill or the 14-in. merchant mill. Approximately 85 per cent of the skelp

TABLE VII

10-In. Skelp Mill

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm
	Maximum diameter	Body length					
No. 1	10¾	15	.....			3.77	17.3/30.6
No. 3	11⅜	15	6-3.446			2.69	24.2/43.0
No. 4	9⅜	15	4-3.682			1.525	42.6/76
No. 5 (Edger)	11⅜	4¼	3-11.989	1300/2000	65/115.4	1.605	40.5/72
No. 6	9¾	15	4-0.733			1.0	65/115.4
No. 7	10	15	8-10.359			0.685	95.1/169.
No. 8 (Edger)	11⅝	4¼	18-1 41/64	167	251/450	3.04	82.5/147.5
No. 9	10⅜	15	15-0			0.988	163/254
No. 10	10⅛	15	8-5½	2000	161/250	0.71	226/352
No. 10-A (Edger)	15	3½	4-2	50	200/800		
No. 11	10¾	15	7-10			0.582	276/430

The lap weld mill produces lap weld pipe 2 to 4-in. in diameter in various grades at rates averaging 22.5 tons per hour.

is bessemer steel, but pipe requiring greater ductility is made from duplexed open hearth steel.

In the lap weld mill, skelp 8 to 15 3/16 in. wide × 0.170 to 0.365 in. thick, with a severe bevel or scarf on each edge, is first put through a cold bending machine, where it is bent into the approximate shape of the pipe, but with one edge overlapping the other by about 3/8 in.

The bent skelp is then put through one of two coke gas fired preheating furnaces, where it is heated to about 1800 F. The skelp is then transferred into the welding furnace, a regenerative unit 7 ft 6 in. wide and 25 ft 6 in. long. This furnace is maintained at 2700 F, and the skelp is heated to 2450 F.

When the formed skelp reaches welding temperature, it is rolled into one of two gutters at the center of the furnace and pushed by a long bar into the 30-in. diameter welding rolls. This roll stand is located directly in front of the welding furnace, and is moved crosswise by a hydraulic cylinder to line up with the two gutters in the furnace.

In the mill, the rolls grip the skelp and pull it over a welding ball held in place by a mandrel bar. Pressure between the rolls and the ball presses the hot plastic edges of the skelp together to form a tight, solid weld. The mandrel bar is extracted and the pipe then passes between a pair of grooved sizing rolls, then over a cooling rack to a cradle. After cooling to about 600 F, the pipe is quenched with water and is ready for finishing.

This mill produces 2 to 4 in. lap weld pipe in standard, line, extra heavy, water well casing and mechanical tubing grades, at rates averaging 22.5 tons per hour. Monthly tonnage averages 11,500 and a monthly record of 13,212 tons has been set.

In butt welding, skelp has only a slight bevel on the edges. The corners of the front end of the skelp are clipped off and the remaining point is cupped and bent up so that tongs may be put on easily. Skelp edges must be free of slivers and pits to insure a good weld.

The sheared skelp is put into the heating furnace by a charging machine which travels across the back of the furnace, moving the skelp by means of magnetic rolls. Skelp must be alined in the furnace so that the edges do not touch each other.

When skelp reaches 2450 F, the welder at the front of the furnace fastens a pair of long, slender tongs over the cupped end of the skelp, and slips a bell-shaped copper alloy casting—a welding bell—over the tongs. The bell and tongs are dropped into the bell block, a slotted casting which holds the bell in place while the tongs, hooked to a draw chain, pull the skelp through the bell, welding the edges together. Oxygen jets are directed on the skelp edges just ahead of the bell block to raise the temperature for better welding.

At the end of the draw, the tongs are removed, and the pipe is put through three pairs of grooved rolls to break the scale and size the pipe. After cooling, both ends of the pipe are cropped by sawing, and the pipe is moved to a cradle to be collected for finishing operations.

No. 2 mill uses skelp 4 1/16 to 11 3/4 in. wide × 0.122 to 0.240 in. thick and makes 1 to 3 in. pipe. It has a regenerative furnace 9 ft 6 in. × 23 ft 3 in., fired with coke oven gas.

No. 3 mill uses skelp 2 5/8 to 5 1/2 in. wide × 0.088 to 0.205 in. thick, and produces 1/2 to 1 1/4 in. pipe. It is served by a regenerative furnace 8 ft 6 in. × 23 ft 3 in., also fired with coke oven gas.

The butt weld mills have a nominal capacity of about 17,000 tons per month. Actually, No. 2 mill has produced 11,892 tons in one month and No. 3 mill 8554 tons.

Finishing operations on welded pipe may include straightening, automatic facing of the ends, threading, hydrostatic testing, oiling, and, of course, numerous inspections. Two lengths of pipe may be welded together to form a double length, if desired. Pipe may be galvanized in two batch type units. Pipe may be given a cement lining by spinning them in a machine while they contain a thin mixture of cement, silica flour, slag and water. When the excess water is drained off and the cement cured, a layer of cement remains around the inside of the pipe.

For lap welded pipe, the skelp is cold formed as shown here before going to the preheating and heating furnaces.

This department also includes facilities for the production of couplings for welded tube products.

SEAMLESS TUBE DEPARTMENT

The seamless tube department consists of a steel conditioning area, a 30-in. round mill, two tube mills, and facilities for finishing and shipping tubes and for producing couplings.

Blooms of open hearth steel in various sizes, ranging from 7 in. × 7 in. to 13 in. × 13 in., are received in cars and unloaded in the conditioning yard. Here the blooms are usually skinned on all four sides by oxyacetylene torch, then pickled for about 20 minutes in an 8 per cent sulphuric acid solution. Defects brought to light by the pickling are then removed by spot scarfing. There are also two mechanical chipping machines and a gouging machine for use on certain grades of steel.

Conditioned billets are then heated in one of three continuous heating furnaces. Two furnaces are 20 ft wide × 65 ft long, while the third is 25 ft wide × 80 ft long. All are of end-charge, side-discharge design, and are fired with coke oven gas or producer gas, with oil as a standby. The large furnace is rated at 50 tons per hr, the smaller ones at 30 tons per hr each.

The heated bloom is moved over roller tables to the 30-in. mill, which is composed of three two-high reversing stands placed side by side, all direct-driven by a 3000-hp, 65 to 130 rpm, 650-volt d-c reversing motor. Two 1600-kw generators supply power for this drive.

On each side of the mill is a traveling table, 49 ft 6 in. long on the entry side, 45 ft on the delivery side.

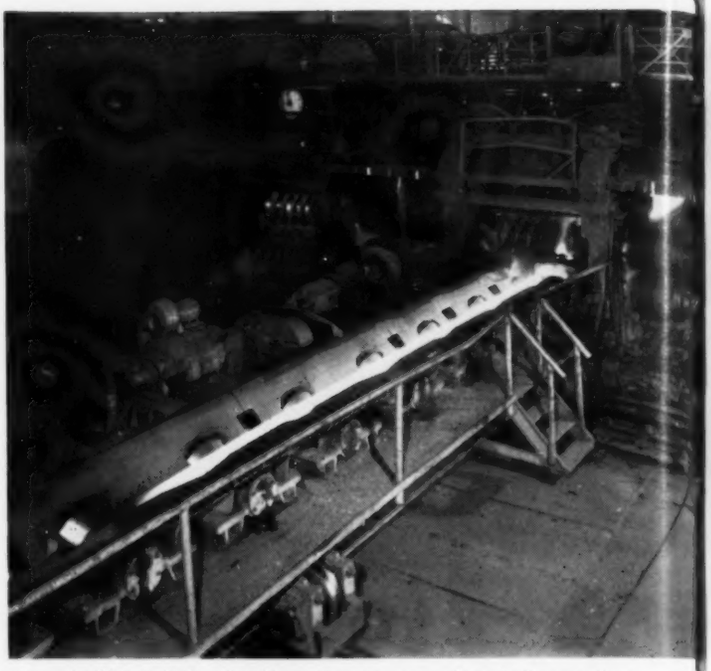
Mill rolls are 32 in. in diameter with a body length of 83 in., and run in babbitted bearings with bronze inserts. Alloy steel rolls are used in the roughing stand, alloy iron in the two finishing stands.

This mill produces rounds of 4¾ to 10 in. diameter for No. 1 tube mill, and 3½ to 6 in. diameter for No. 2 tube mill. An average rolling rate of 66.9 net tons per hour is maintained, but records of 939 tons per 8-hour turn, 2459 tons per day, and 51,800 tons per month have been made. Power consumption averages about 28 kwhr per ton rolled.

The size of the round varies with the size of tube to be produced as follows:

Round diameter, in.	Outside diameter of tube, in.
3½	2⅜
4	2⅞
4½	3½
5	4½
5 or 6	5½
5¾	6⅝
5¾ or 6½	7
6½	7⅝
7	8⅝
7 or 7½	9⅝
7½ or 9	10¾
9 or 9½	12¾
9½	12⅜
9½	14

Finished rounds, 50 to 60 ft long, are then cut into desired lengths at either of two hot saws. One saw, a screw-operated sliding type, is 54 in. in diameter and cuts rounds up to 10 in. in diameter. It is located in line with the second mill stand, and 199 ft away. The other saw, of swinging type, has a 50-in. blade and cuts material up to 6-in. in diameter. It is in line with the third mill stand, and 142 ft away.



Rounds 3½ to 10 in. in diameter for seamless tube production are rolled on this 30-in. mill. The steel is handled by traveling tables on both sides of the mill.

After sawing, each piece goes to a centering machine, where an indentation is made in the center of one end. The rounds are then transferred by buggy to the seamless mills, which are located in another building a short distance away.

At the seamless mills, the rounds are reheated in four end-charge, side-discharge, continuous furnaces. Three of these are 20 ft wide × 57 ft 1½ in. long, the fourth is 25 ft wide × 66 ft long. The hearths of all furnaces slope 1½ in. per ft, so the billets roll down toward the discharge end. The furnaces are fired with producer gas, coke oven gas or fuel oil. Fuel consumption averages 2,716,000 Btu per ton.

These furnaces discharge rounds heated to 2150 to 2250 F, depending on the type of steel, on to a common conveyor table, so that any furnace may feed to either of the two mills if necessary.

No. 1 seamless mill has a size range of 5½ to 14 in. diameter tubes, in lengths of 22 to 46 ft. The heated billet is conveyed to the first piercer, a heavily designed unit with conical, cast alloy steel rolls which revolve the billet as it is forced over the piercer point on the mandrel bar.

The first piercer transforms the solid round into a hollow cylinder which is then transferred to the second piercer, which is essentially a duplicate of the first. Here the hollow cylinder is expanded and elongated by being forced over another mandrel plug.

The rough tube is then transferred to the plug (or high) mill, where it is further rolled out over a plug to the approximate wall thickness desired.

Following this, two reelers again roll the tube over mandrels, slightly expanding the diameter and smoothing the inside and outside surfaces.

Finally, the tube is finished to the desired outside diameter in the sizing mill, which consists of five stands of grooved rolls driven by a single 400 hp motor.

TABLE VIII

Seamless Tube Mill Drives

	Roll size, in.		Motor hp	Motor voltage	Motor rpm	Gear ratio	Roll rpm
	Nominal diameter	Body length					
No. 1 Mill							
No. 1 Piercer	40	24	3000	6600 a-c	250	3.095	81
No. 2 Piercer	40	24	3000	6600 a-c	250	3.095	81
Plug mill	38	56	1500	6600 a-c	375	5.560	67
Reeler	30	28	500	230 d-c	400/800	3.755	105/210
Reeler	30	28	500	230 d-c	400/800	3.755	105/210
Sizing mill (5 stands)	28½	17	400	6600 a-c	490	4.053	121
No. 2 Mill							
Piercer	40	20	2000	6600 a-c	250	3.182	79
Plug mill	28	55	1000	6600 a-c	375	3.780	99
Reeler	30	23	350	230 d-c	275/550	4.017	68/136
Reeler	30	23	350	230 d-c	275/550	4.017	68/136
Reducing mill (12 stands)	15½	9	400	6600 a-c	500	8.167	61
Reducing mill (12 stands)	15½	9	400	6600 a-c	500	8.167	61
Sizing mill (5 stands)	18½	11	250	220 a-c	500	5.770	87

Table VIII gives data on the drives of the seamless tube mills.

No. 1 tube mill is a high production unit and often rolls 18 to 20 miles of line pipe per day. Tonnagewise, this mill turned out as much as 2012 tons in a day and 34,037 tons in a month.

Power consumption averages 30 kwhr per ton of product on this mill.

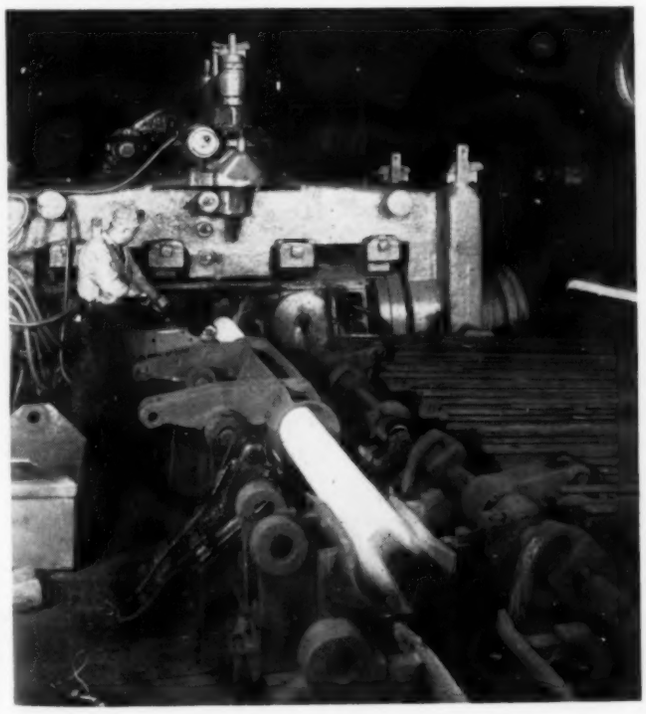
No. 2 seamless mill produces tubes of 2⅜ to 6 in. outside diameter in 22 to 44-ft lengths. It differs somewhat from No. 2 mill. Because of the smaller sizes, only one piercing unit is installed.

The pierced billet then goes, as in the larger mill, to the plug mill and to the reelers. From this point, it may either go to a five-stand sizing mill or it may be put through a reheating furnace and then through one or two reducing mills, each consisting of 12 stands on 36-in. centers.

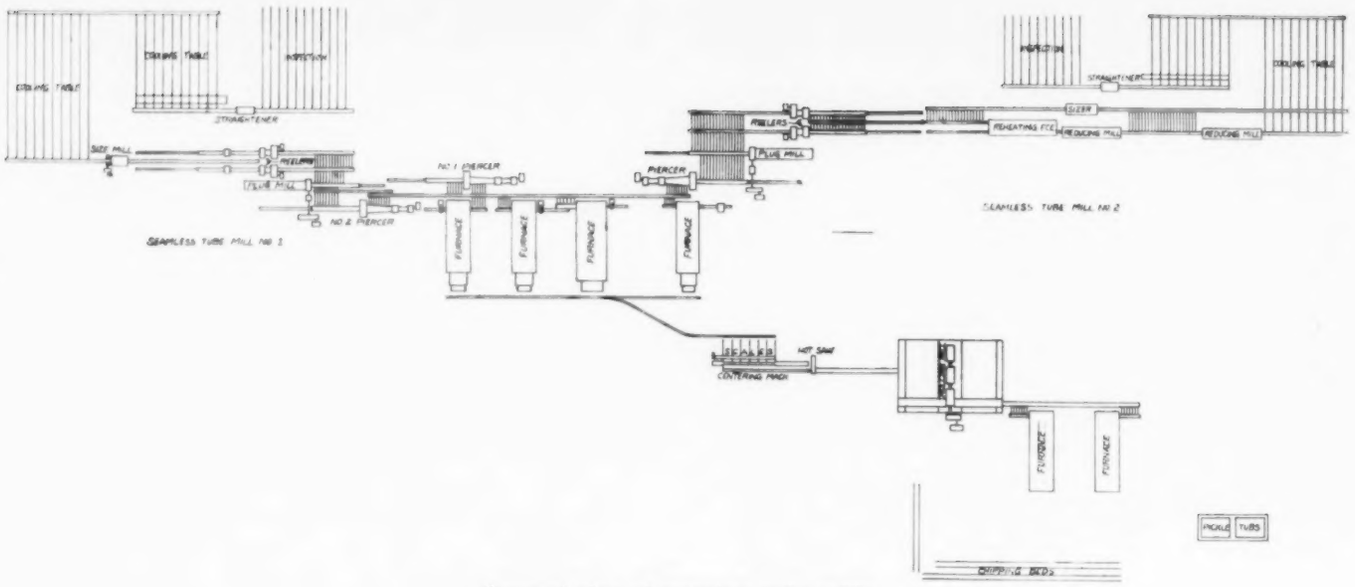
No. 2 mill consumes about 45 kwhr per ton of product. This mill's tonnage is about half of that of No. 1, records having been set at 996 tons in a day and 19,337 tons in a month.

The two tube mills work with opposite directions of product flow. Tubes from each mill are conveyed to the finishing floor on long cooling racks which operate slowly to permit the tubes to cool sufficiently to be

In the production of seamless tube, heated rounds are first put through a piercer, where it is forced over a piercer point on the end of a mandrel bar.



The pierced round is put through a plug mill, where it is further rolled out over a plug to the approximate wall thickness desired.



General plan of seamless tube mills.

straightened when they arrive at the end of the rack.

After straightening, the product is put through various finishing operations, depending on the class of product. All types are routed to cutting-off machines followed by inspection and seam grinding. In some cases, an upsetting operation precedes the final finishing.

Product requiring threading then goes to threading machines and is then inspected and tested, after which it is marked, provided with thread protectors and couplings, and stocked or shipped. Some grades are normalized and inspected after straightening, before the other operations. Other processes are also used to meet special customer requirements.

A separate shop makes couplings for the seamless products.

A recent addition to tube producing facilities is the seamless tube specialties department. Located in a building 100 ft × 725 ft are two hearth-type gas-fired furnaces, with a water spray quenching unit between them. One furnace is a high-temperature unit which is used to heat for quenching or for normalizing. The other is a tempering furnace, for use after quenching.

By careful heat treatment, high strength seamless pipe may be produced with lower alloy contents than were formerly needed.

Other equipment in the new building includes a three-stand sizing mill, a rotary straightener, a gag-press straightener, cut-off and threading equipment and storage racks.

ROD AND WIRE MILL

Wire forms an important item in the production of Aliquippa Works. To supply rod for the production of wire, a new three-strand rod mill was installed in 1951, replacing two old mills. This mill is currently producing rods from $\frac{7}{32}$ in. to $\frac{21}{32}$ in. inclusive, but this range can be increased to $1\frac{1}{8}$ in. if desired. All sizes may be triple-stranded.

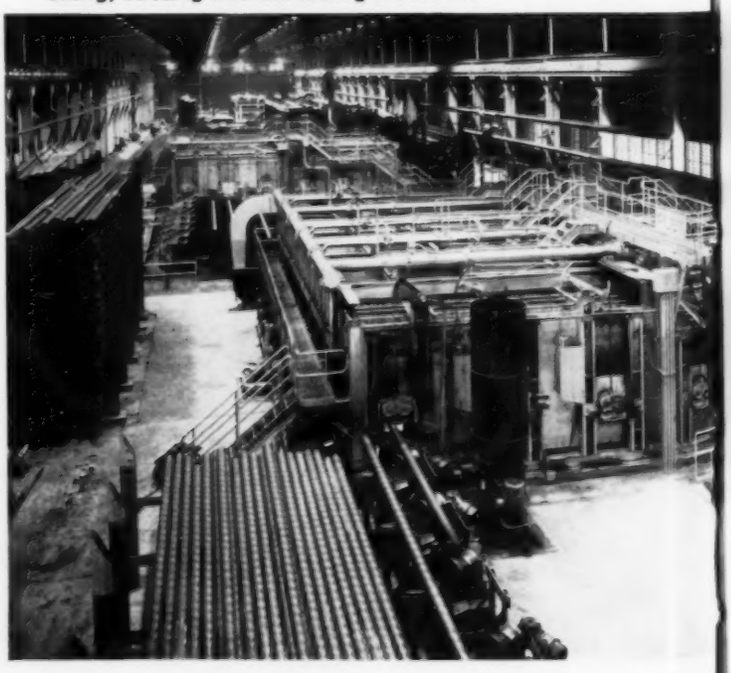
The new mill is supplied with $2\frac{1}{2}$-in. square billets, 30 ft long, from the billet mill. Billets are loaded on a bundle buster which separates the billets and feeds them, one by one, to the furnace charging table.

Billets are heated in an end-charged, side-discharged, continuous heating furnace 33 ft wide × 63 ft long, rated at 75 tons per hour. This furnace is fired by natural or coke oven gas, in a two-zone heating arrangement. Complete automatic furnace controls are provided. Fuel consumption averages 1,200,000 Btu per ton.

As a heated billet is pushed from the furnace, it passes through a pair of pinch rolls and a hydraulically operated switch which directs the billet into the proper pass line. There is also a safety shear here to cut up the billet in case of a cobble in the roughing train.

The roughing train consists of eight stands (two 16-in., six 15-in.) in line. The intermediate train is made up of eight 12-in. stands, four of which are in line with the roughing train, while the other four are placed in two pairs. Repeaters reverse the flow of the steel after stand No. 12 and after stand No. 14. A third

In the seamless tube specialties department, high strength pipe progresses automatically from the feed table through the heat treating furnaces and into straightening, cutting and threading machines.



This modern three-strand rod mill, which replaced two old mills in 1951, reduces 2½-in. square billets to rods of 0.218 to 0.656 in. diameter with delivery speeds of 5000 fpm or more.

repeater after stand No. 16 leads the steel back into the finishing train, which consists of six stands, two of 10.063 in. pitch diameter, two of 10.5 in., and two of 11 in.

All roughing and intermediate stands are driven in pairs by 500 or 800-hp motors, while a single 2000-hp motor drives the finishing train. All of these motors are 600-volt, d-c units. The motors on the roughing and finishing stands receive power from two 1500-kw, 600-volt generators, the intermediate stand drives from a 2250-kw generator. Table IX gives data on the individual stands and their drives.

Power consumption averages about 100 kwhr per ton for main drives, auxiliaries and lighting.

In all stands, both top and bottom rolls may be adjusted, and are separated by hydraulic pressure. Roller bearings are applied to all roll necks, gear sets and pinions. All stands are driven through gear-type couplings. Roughing and intermediate stands are mounted on sliding bases and are shifted by hydraulic cylinders to maintain pass lines.

The mill is lubricated by three automatic grease systems and three circulating oil systems.

Cast iron guides are used in the roughing and intermediate trains, with roller twist guides to turn the diamond and oval sections. Bronze guides are used in the finishing train.

Diamond and square passes are used in the roughing train, and oval and square passes in the intermediate and finishing stands. The front end of the billet is cropped by an electrically operated flying shear between the roughing and intermediate trains.

Pass reductions are of the order of 20 to 25 per cent in the roughing stands, 15 to 25 per cent in the intermediate stands, and 10 to 20 per cent in the finishing stands.

Sections from $\frac{7}{32}$ in. up to and including $\frac{11}{32}$ in. are finished out of the finishing train, with stands being removed in pairs from the finishing train as the size goes up.

Rod leaving the finishing train goes to one of six laying reels, where it is coiled. High-pressure water jets between the mill and the reel serve to reduce the temperature of the rod.

Sizes of $\frac{23}{64}$ in. and larger do not go through the finishing train, but are finished out of the intermediate

Cold drawing of wire is performed principally on continuous drawing machines. The wire mill produces a full range of wire sizes and grades.

TABLE IX

10-In. Rod Mill

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm	Roll face speed, fpm
	Nominal diameter	Body length						
No. 1	16 7/8	28	.....	500	300/900	32.986	9.09/27.28	38/114.15
No. 2	17 1/8	28	7-0			25.815	11.62/34.86	47.95/143.86
No. 3	16 1/8	28	7-0	500	300/900	18.545	16.18/48.53	64.1 /192.31
No. 4	16 1/8	28	6-0			14.424	20.29/62.39	82.08/246.23
No. 5	16 1/8	28	6-3	500	300/900	11.036	27.19/81.55	110/330
No. 6	16 1/8	28	6-0			8.583	35/105	140/421
No. 7	16 1/8	28	6-0	500	300/900	6.493	46.3/139	188/565
No. 8	16 1/8	28	6-0			5.050	59.3/178	240/721
No. 9	12 3/8	26	21-4	800	300/900	3.820	79/236	260/779
No. 10	13 1/16	26	5-0			3.00	100/300	332/995
No. 11	12 13/16	26	16-4	800	300/900	2.9375	102/306	340/1021
No. 12	13 1/16	26	5-0			2.2708	132/396	438/1315
No. 13	12 29/32	26	.....	800	300/900	1.7544	171/513	579/1737
No. 14	13 1/16	26	5-0			1.4035	214/641	711/2132
No. 15	13 1/16	26	.....	800	300/900	1.250	240/720	807/2420
No. 16	13 1/16	26	5-0			1.0417	288/864	964/2907
No. 17	10 3/16	20	.....			0.6064	495/1120	1320/2990
No. 18	10 5/16	20	3-0			0.5242	573/1297	1535/3476
No. 19	10 21/32	20	3-0	2000	300/900	0.4507	666/1508	1837/4160
No. 20	10 63/64	20	3-0			0.3990	752/1704	2106/4772
No. 21	11 1/8	20	3-0			0.3417	878/1989	2523/5716
No. 22	11 1/2	20	2-10			0.3107	966/2187	2825/6400

stands. Here again, as the size goes up, stands are removed in pairs from the intermediate train. At the current maximum size of $\frac{21}{32}$ in., only four of these stands remain in the mill.

Rod finished out of the intermediate train is coiled in one of six pouring reels.

Coils from the laying or pouring reels are discharged on to a drag conveyor system, transferred to a hook-type conveyor and transported to a storage area until loaded for shipment or for use in the wire mill.

Maximum speeds of 6400 fpm out of stand No. 22 and 2907 fpm out of stand No. 16 are available, but actual finishing speeds are generally somewhat lower.

The mill averages about 44 net tons per gross operating hour, but has produced as much as 81 tons in one hour, 492 tons in an 8-hour turn, 1182 tons in a day, and 25,100 tons in a month.

In the wire mill, hot rolled rod is processed into a full range of wire sizes and grades. Rods are first pickled to remove scale from the hot rolling, then given a lime coating and baked.

Cold drawing is performed on eight straight drawing benches with a total of 136 spindles, nine bull blocks for heavy single draft work, four double-deck machines for double draft work, 61 continuous machines capable of making up to seven drafts in tandem, 11 continuous machines for "dry drawing" fine wire, and 19 continuous machines for "wet drawing" fine wire. This drawing equipment can produce material running from 0.006 in. diameter up to 1 in. diameter.

To meet desired physical characteristics and finish, an extensive layout of auxiliary processing equipment is provided. Four gas or oil-fired furnaces handle multiple strands of wire for in-process annealing of high carbon grades. There are also three strand-annealing units in which the wire is heated by electric resistance. Two of these units may be converted to produce oil tempered finished mechanical spring wire. In addition, five bell-type furnaces with 14 bases and neutral atmosphere equipment may be used for in-process annealing or finish annealing of wire coils.

Galvanizing equipment consists of three large units capable of producing various galvanized coatings, and another unit for coating fine wire.

A full line of nails and staples are produced on 148 nail machines and four staple machines. Equipment for sterilizing, galvanizing or coating, cleaning, weighing and packaging these products is provided. Wire fence is made by seven field fence machines and 42 barbed wire machines. Ten straightening and cutting machines are available for the production of cut material ranging from reinforcing bars to florist wires.

Currently under way is a program to increase the flexibility of the wire mill through the installation of 12 high speed continuous wire drawing machines in place of four of the straight benches, the addition of another patent annealing furnace, and additional warehouse facilities.

TIN MILL PRODUCTS

The tin mill at Aliquippa was modernized and expanded in 1947, replacing old facilities for tin plate production. It now occupies about 20 acres toward the south end of the plant and has an annual rated capacity of 500,000 net tons.

Hot rolled coils, weighing 6000 to 10,000 lb each, are brought to Aliquippa by rail from the company's 96-in. strip mill at the Pittsburgh Works. They are first cleaned of all hot-mill scale by pickling in a continuous line rated at 54,000 tons per month. The entry end of this line is composed of the usual expanding mandrel feed reel, a scale-breaking processor, a shear for trimming coil ends, an electric flash butt welder, a looping pit and pinch rolls.

Next in line are four pickling tanks 80 ft long × 4 ft 6 in. wide × 4 ft deep, constructed of rubber covered steel plate and lined with 10 in. of brick set in acid resistant cement. Each tank holds about 9500 gal

◀ **Wire and wire products form an important part in the product mix of the Aliquippa Works. Shown here, from top to bottom, a patent annealing furnace for heat treating spring wire; woven wire fence machines; a battery of nail machines; and a barbed wire machine.**

of solution containing, in the various tanks, 8 to 23 per cent sulphuric acid. These tanks are covered and vented to a fume disposal system. The pickling solutions are held at about 210 F by the injection of steam.

Immediately after the acid tanks are a cold water rinse tank and a hot water rinse tank, followed by a dryer, an edge trimmer, an oiler and a recoiling reel. Coils formed here are made up of several of the hot rolled coils, and are approximately 72 in. outside diameter.

The pickling line is driven under adjustable voltage control and operates at speeds of 500 fpm or more.

Pickled coils are then ready for the cold reduction process, which is carried out in a five-stand, four-high 21½ in. and 53 in. × 42 in. tandem mill, some details of which are given in Table X.

This mill is of unusually heavy construction. Roller bearings are applied to all work roll necks, with oil-flooded bearings of 3,000,000-lb capacity each on the back-up roll necks. Screwdowns on each stand are operated by two 75-hp mill type motors under adjustable voltage control.

As may be noted from Table X, the main drives of this mill are rather unusual. No. 1 stand has a single motor drive through pinions. No. 2 stand is also driven through pinions by two motors in tandem on one shaft. No. 3 is a twin drive with a separate motor driving each work roll through speed-increasing gears. No. 4 stand is similar to No. 3, but with a different gear ratio. No. 5 stand is also a twin drive through speed-increasing gears but has two motors on each work roll. This arrangement was used to keep inertia of the drives at a minimum.

The drive motors operate under adjustable voltage control, drawing power from two motor-generator sets with a separate generator for each stand drive. No. 1 stand is served by a 1500-kw generator, No. 2 and No. 3 stand by a 3000-kw generator each. The second set has a 3000-kw generator for No. 4 stand, a 3200-kw generator for No. 5 stand, and a 500-kw generator for the tension reel. Each set is driven by a 10,000-hp synchronous motor.

Because of special insulation used in the drive motors, they can be operated steadily at as much as 20 per cent overload.

The two independent gear sets on stands No. 3, 4 and 5 are mounted in a common one-piece, cast housing. Gear diameters were held to a minimum and three-bearing construction was used for maximum rigidity.

A recirculating oil system provides lubrication for the back-up rolls, and another serves the drives and screwdown mechanisms. An automatic high pressure system furnishes grease for work roll bearings. Palm oil for the strip in the mill is supplied by a recirculating system.

The tandem mill takes hot rolled, pickled strip 0.075 to 0.100 in. thick up to 38 in. wide and reduces it to a minimum gage of 0.0072 in. It has a monthly capacity of about 53,000 tons, and is capable of delivery speeds up to 6000 fpm, although normal operation is of the order of 4500 fpm.

TABLE X
Cold Mill Data

Stand	Work roll		Back-up roll		Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll rpm	Roll face speed, fpm
	Diameter, in.	Body length, in.	Diameter, in.	Body length, in.		Hp	Voltage	Type	Rpm			
Tandem Mill												
No. 1	21½	42	53	42	—	1750	750	d-c	80/240	Direct	80/240	450/1351
No. 2	21½	42	53	42	13-6	(2)1750	750	d-c	150/360	Direct	150/360	844/2026
No. 3	21½	42	53	42	13-6	(2)1750	750	d-c	175/350	0.655	267/534	1502/3004
No. 4	21½	42	53	42	13-6	(2)1750	750	d-c	200/400	0.50	400/800	2251/4503
No. 5	21½	42	53	42	13-6	(4)1000	750	d-c	275/535	0.50	550/1070	3096/6023
Reel	—	—	—	—	—	(2) 300	375	d-c	300/1200	—	—	—
Temper Mill												
Entry puller	24	—	—	—	—	300	600	d-c	850/1500	Direct	—	—
No. 1	19	48	49	48	—	(2) 400	600	d-c	400/600	Direct	400/600	5130/7692
No. 2	19	48	49	48	13-0	(2) 600	600	d-c	1150/1500	Direct	1150/1500	5715/7450
Exit puller	24	—	—	—	—	(2) 600	600	d-c	850/1500	Direct	—	—
Tension reel	15	—	—	—	—	600	375	d-c	300/1500	0.987	—	—
Temper mill	19	43	39¾	42	—	250	250	d-c	490/650	Direct	490/650	2440/3240
Tension reel	—	—	—	—	—	400	—	—	600/1715	—	—	—
Temper mill	19	43	39¾	42	—	250	250	d-c	490/650	Direct	490/650	2440/3240
Tension reel	—	—	—	—	—	400	—	—	600/1715	—	—	—

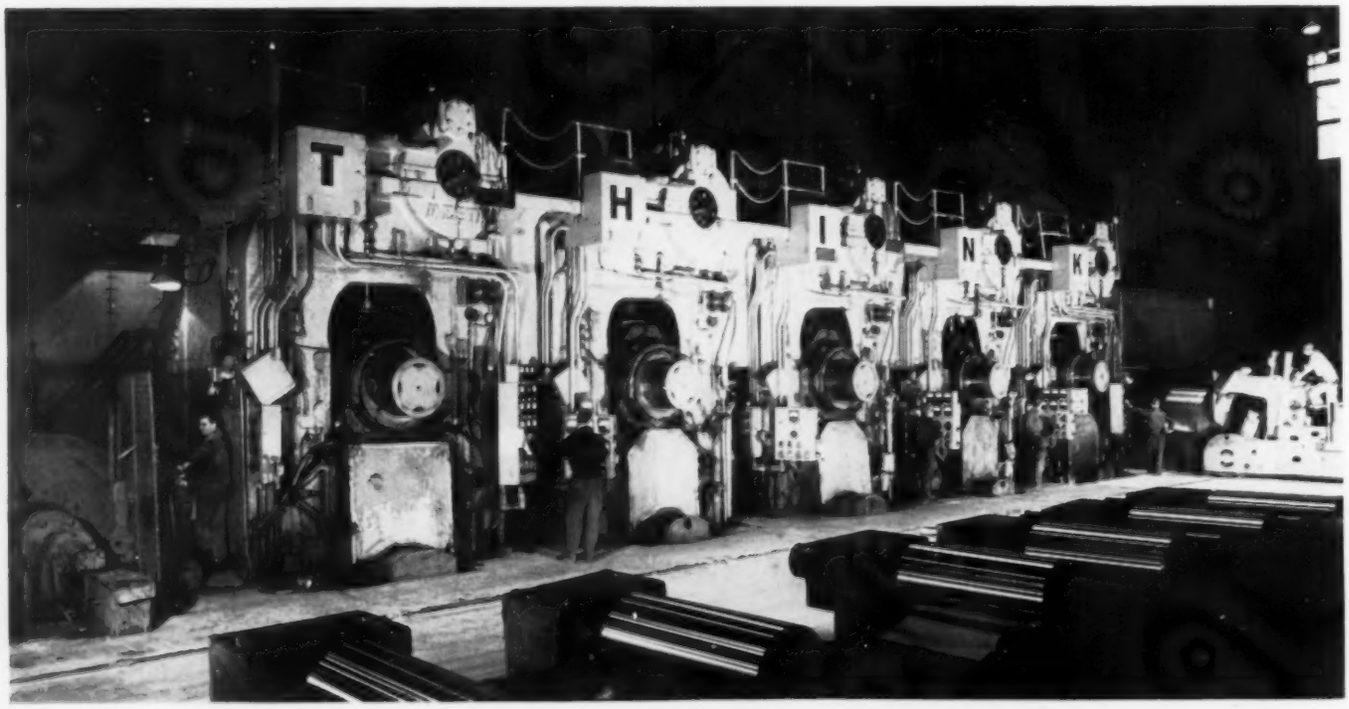
As a guide in tension control, an indicating tensiometer is located between each pair of stands. Strip gage is maintained by reference to an X-ray gage following the last stand.

After cold rolling, coils are moved by industrial truck to three electrolytic cleaning lines where the oil from the cold rolling process is removed in an electrolytic caustic tank. One of these lines operates at speeds up to 2500 fpm, the other two at 1800 fpm.

The 52-in. diameter coils formed at the cleaning lines are up-ended, weighed and taken to the annealing department. Here they are piled on bases — eight stacks, three-high, for a total of about 300,000 lb. Each stack is covered by a cylindrical inner cover, and a portable furnace cover is put over all. These furnace covers are 23 ft long × 14 ft wide × 16 ft high, and are heated by coke oven gas burned in radiant tubes. Gas and air are proportioned and premixed by a carburetor on each furnace. A deoxidizing atmosphere, supplied by four gas preparation machines, is maintained within the inner covers.

Automatic temperature controls are mounted on each

This five-stand, four-high 21½ in. and 53 in. x 42 in. tandem cold mill has a maximum delivery speed of 6023 fpm. At present, it rolls coils from the hot strip mill at Pittsburgh Works.



The main drives of the tandem cold mill, housed in this room, are rather unusual, with twin drives on the last three stands. Drives and controls were designed for flexibility and acceleration.

furnace cover and coil temperatures are recorded in a central control room. Fuel consumption averages 750,000 Btu per ton annealed.

Normal annealing cycles are 20 hours heating, 1 to 7 hours soaking, and 38 hours cooling. The cooling cycle is speeded up by the use of 12 specially designed portable cooling covers which are set over the charge after the furnace cover is removed. Eight fans in each cooling cover circulate air over the hot inner covers, speeding the cooling.

The annealing department contains 13 portable cover furnaces and 36 bases.

Annealed coils are moved by conveyor to the temper mills, where a light reduction, or "skin-pass," is made to impart good surface to the strip and bring it to the desired hardness and stiffness. Most of the tonnage is rolled on a two-stand unit which was put into operation in 1951. Both stands are driven by twin motor drives, with the motors on the second stand of double armature design. Table X gives data on this mill.

A rather unusual feature of this mill is that No. 1 stand is able to use work rolls ranging from 10 to 19 in. in diameter, making the mill very flexible. In No. 1 stand, the back-up rolls are driven, while in No. 2 stand, the work rolls are driven.

The drive motors receive power from a 2000-kw, 600-volt, d-c motor-generator set.

Work rolls in this mill are of forged steel, with those in the first stand having a shot blasted finish and smooth rolls in the second stand.

There are also two single stand temper mills as listed in Table X. The drive of each of these mills is served by a 500-kw, 250-volt motor-generator set.

Coils may now be shipped as black plate without further processing or they may be taken to the tinning departments. In some cases, coils may require special preparation which is carried out in four coil preparation lines. Three of these lines have side trimmers and all four are equipped with welders. Coils may be trimmed to specified width or inspected for shape, surface and hardness.

Tinning is performed either by electroplating or by hot dipping. There are three electrolytic lines. The newest is a halogen type line 458 ft long, capable of putting on coating weights of 0.10 to 1.00 lb per base box. It will handle strip up to 38 in. wide and is capable of speeds up to 2250 fpm.

This line contains pay-off reels, shear, welder, looping pit, alkaline cleaner, pickling tank, scrubbers, plating tanks, 1800-kw induction brightening equipment, flying shear and tension reels. Two horizontal plating tanks, each containing 12 plating cells, are located one above the other, and the strip doubles back and forth in horizontal planes as it passes through. Since only one side of the strip is plated in each tank, and since plating current to each cell is individually controlled, the two sides of the strip may be coated with different coating weights. A total of 180,000 amperes plating current is available.

The other plating lines have essentially the same principal parts, but have vertical plating tanks through which the strip doubles back and forth in vertical planes. They have looping towers instead of a pit, and operate only up to 1000 fpm. Both lines have a 900-kw induction brightening unit. One of these lines uses the alkaline plating process, and has 90,000 amperes plating current capacity. The other line has been converted from the alkaline process and now uses the halogen electrolyte. It has 48,000 amperes plating current capacity.

X-ray gages, designed and developed by the company, are installed on all three electrolytic lines to provide a continuous, accurate check on tin coating thickness.

Total capacity of the electrolytic tinning lines is approximately 37,000 tons per month, with about 75 per cent having a coating weight of 0.25 lb per base box and the balance 0.50 lb, 0.75 lb, 1.00 lb, and 1.00/0.25 lb coatings

Six rotary flying shear lines are provided to cut up coils, which may be of black plate for shipment, of electrolytic tin plate or of black plate intended for hot dip tinning. These units have side trimmers and are equipped with beta-ray thickness gages and pin hole detectors. Sheared tin plate is separated into primes and off-grade material. The latter is taken to the assorting department for further inspection and sorting. Prime electrolytic and black plate product intended for shipment is carried by tractor to the packing conveyor. Prime black plate intended for tinning goes to the hot dip tinning department.

This cut-to-length black plate is first given a light pickle in 3 per cent sulphuric acid solution in a four-arm white pickler. It is then moved to one of ten hot-dip tinning machines where coatings of 1.25 to 1.50 lb per base box are applied at speeds up to 500 in. per minute. Defective electrolytic plate may also be reclaimed by hot dipping.

Hot dip plate is then assorted, counted and transported to the packing area. Here prime plate is packed on an 88-ft conveyor which travels at 50 fpm. The packed plate is then put into warehouses that will hold 60,000 tons of product. Temperature in these buildings is automatically controlled for protection of the product. From here, the product is shipped out by rail or truck.

SERVICE DEPARTMENTS

Quality control from raw materials to finished products is a primary obligation of the metallurgical department. The main metallurgical building is centrally located in the plant, and houses — in addition to offices — physical and metallographic laboratories, and extensive tabulating equipment for statistical records of processing details. The physical laboratory contains a machine shop, testing equipment and facilities for heat treatment of samples. The metallographic laboratory is equipped for photomicroscopy and photography.

The metallurgical department consists of four major divisions serving the various production units: steel works, tubular products, tin plate and wire products. In addition, there is a technical service division which handles customer problems, tabulated records, etc. Steel works division is responsible for checking and enforcing quality requirements at the blast furnaces, bessemer, open hearth, and blooming, bar, billet, skelp and merchant mills. It is this section's job to observe steelmaking details, heating and rolling temperatures, surface conditions, discarding, chemical analyses and other characteristics dictated by customers' requirements.

•The tube investigation group is responsible for establishing and maintaining the quality standards of tubular products. This includes setting up steel grades, follow-up on various processing steps, checking inspection standards and establishing heat treating cycles. They also check performance properties and conduct development work.

The tin plate and wire mills have their own laboratories under metallurgical supervision. At the tin mill a modern chemical laboratory, as well as inspection and physical testing stations in the mill, are used to control processes and check tin plate quality. There is constant investigation of production problems and of possibilities of improving processes and product.

The wire mill is organized along the same general lines, with laboratory, inspection, observation and investigational groups. Rod and wire products are tested in accordance with their end use. This group also maintains a constant check on cleaning and coating compounds and solutions.

Continuous alkaline cleaners remove oil from cold reduced strip before it goes to the annealing furnaces.

To accommodate river barge shipments of products, a modern dock is located at the extreme south end of the plant. The wharf, 300 ft long, is constructed of steel sheet piling and has ten mooring cylinders and three ice-breaker cylinders. Part of the dock is covered by a building 150 ft × 138 ft, served by a 15-ton crane. Two railroad tracks pass through the building, so that material can be handled by crane directly from gondola cars to barges. Material from box cars can be moved by lift trucks to the loading platform, then handled by crane into barges.

The company's traffic and transportation division operates six river towboats and a great many barges of various types.

Railroad traffic is handled partially by plant equipment and trackage, partially by the Aliquippa and Southern Railroad. The plant has 36 miles of standard gage track, the A&S, 45 miles. All locomotives are diesel-electric. There is also a small stretch of narrow gage track between the open hearth and blooming mill, handling ingot buggies.

All maintenance and a considerable portion of the construction work at Aliquippa are handled through an extensive shop system. There are five complete machine shops containing various sized lathes, planers, shapers, boring mills, milling machines, gear cutters, drill presses, slotters, grinders, etc. The largest shop, the general machine shop, is located in the north mill area and does work for all mills. A forge and blacksmith shop adjoins this machine shop. The south mill shop and the tin mill shop do work for the tin mill and the rod and wire department. The seamless tube and welded tube departments each have their own shop.

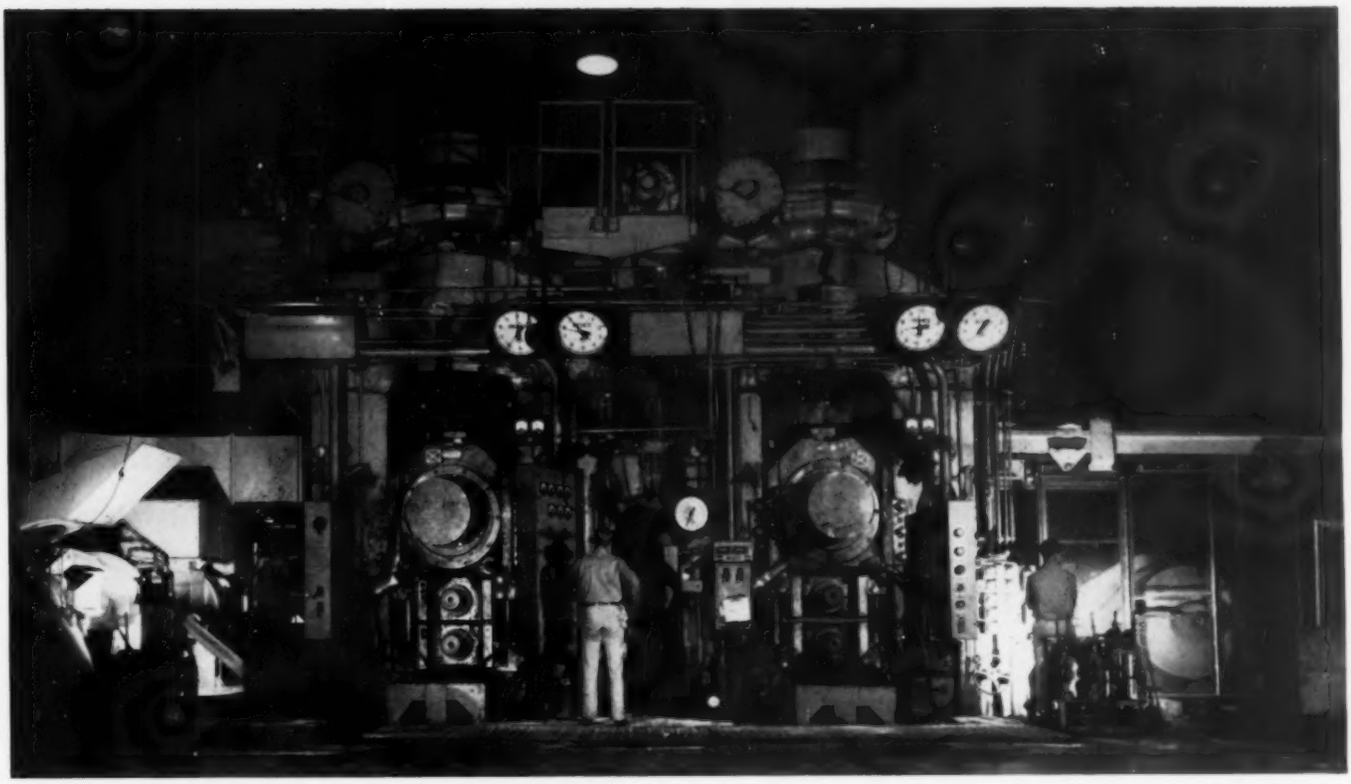
All plate fabrication and welding, as well as most of the boiler repair work, is handled by the boiler shop. Motor repair work is done by the electrical shop, and a line and wire gang maintains the electrical distribution system and does a major part of the electrical construction work.

There is also a tin shop, a carpenter shop, a paint shop and a pipe shop, all equipped to carry out their respective crafts as called for by maintenance and construction programs.

UTILITIES

With full operations, Aliquippa Works uses about 52,000,000 kwhr of electric power per month. About half of this is generated at 25 cycles in the plant, and half is purchased at 60 cycles from the public utility system.

Power is generated in the north and south power houses, which are about two miles apart, but tied together by two transmission lines. In the south power house are three turbo generators, one rated at 17,000 kw driven by a 12-stage turbine, two at 10,000 kw driven by 10-stage turbines. All of these generate at 6900 volts, 25 cycles and operate at 1500 rpm on 225-psi steam. The north power house contains one 20,000-kw, 6900-volt unit, driven by a 14-stage, 1500-rpm turbine operating on 435-psi steam.



This two-stand temper mill, with a maximum delivery speed of 7450 fpm, makes a skin pass on the annealed strip to restore temper and improve surface.

Purchased power enters the plant principally from a 69,000-volt switching station adjacent to the utility company's Hopewell sub-station. From this point there are two 69,000-volt lines, one to the south mills sub-station, one to the north mills sub-station.

The south mills sub-station contains four 20,000-kva, 69,000/6900-volt transformers, from which power is distributed to the tin plate department, rod and wire department and the south frequency changer. At the north mills sub-station, there is one 20,000-kva, 69,000/6900-volt transformer serving the blooming mill, 14-in. merchant mill, seamless tube mills and the north frequency changer.

Distribution of 25-cycle power is entirely by overhead open wire, while 60-cycle power is carried principally by overhead and underground cable. The 69,000-volt lines, however, are open wire.

The 25-cycle and 60-cycle systems are tied together by the two frequency changers. The south unit is 27,000-kva capacity, the north unit 10,000 kva. Both units can operate with power flow in either direction, but normally feed from the 60-cycle system into the 25-cycle system.

There are some 40 transformer installations ranging 500 to 4500 kva throughout the plant, supplying 220 and 440-volt power. Direct-current is supplied in various load centers by motor-generator sets, rotary converters, rectifiers and engine-driven generators.

Steam for the Aliquippa plant is generated in three separate boiler plants, each serving the section of the works in which it is located. Table XI gives principal characteristics of the boilers.

The ten boilers in the by-product house generate steam for the coke plant and for two turbine-driven river pumps located nearby. Coke breeze, burned on traveling grate stokers, is the principal fuel, with coke oven gas and coal available as auxiliary fuels.

The north mills boiler plant consists of four boiler houses located near the blast furnaces. No. 1, 3 and 4 houses furnish steam for a low pressure system which supplies blowing engines, engine-driven d-c generators, pumps, fuel atomizing, heating, etc. No. 5 house provides steam for the four turbo-blowers and the 20,000-kw turbo-generator, as well as, through a pressure-reducing desuperheating unit, make-up steam for the low pressure system. No. 1 house uses blast furnace gas direct from the dust catchers, while No. 3, 4 and 5

This electrolytic tinning line, the newest of three, will handle strip up to 38 in. wide and is capable of speeds up to 2250 fpm.

TABLE XI
Boiler Data

	By-product boiler house		North mills boiler plant					South mills boiler plant		
			No. 1 house	No. 3 house	No. 4 house	No. 5 house		Tin mill	Waste heat	No. 3 house
No. of boilers	8	2	11	10	3	2	1	12	2	5
Type	Horizontal tube	Bent tube	Bent tube	Bent tube	Horizontal tube	Horizontal tube	Horizontal tube	Bent tube	Horizontal tube	Bent tube
Capacity, lb per hr	25,000	60,000	15,000	15,000	90,000	225,000	400,000	15,000	60,000	150,000
Pressure, psi	190	190	150	150	170	435	435	150	150	225
Temperature, F	510	510	Saturated	Saturated	525	700	700	410	500	525
Heating surface, sq ft	5,087	8,200	3,970	3,970	14,750	24,940	24,857	3,970	15,300	19,690
Water walls, sq ft	—	887	—	—	—	—	4,263	—	—	—
Air heater, sq ft	—	—	—	—	—	28,600	40,750	—	—	—
Fuel	Coke breeze, coke gas, coal	Coke breeze, coke gas, coal	Blast furnace gas	Blast furnace gas	Blast furnace gas	Blast furnace gas, powdered coal	Blast furnace gas, powdered coal	Fuel oil	Fuel oil	Powdered coal, coke gas

houses receive partially cleaned hot gas. Powdered coal for No. 5 house is supplied by a bin system from two ball mills, each of 15 tons per hr capacity.

Treated water is supplied to the boilers at the by-product and north mills houses from a hot process lime-soda softener. Make-up water is 100 per cent for all of these boilers except in No. 5 house, where condensate from the turbines reduce make-up to 50 per cent.

At the south mills, there are three boiler houses, located south of the tin mill. The boilers in the waste heat house originally recovered waste heat from old rectangular coke ovens, but since use of these ovens has been discontinued, the boilers are fired with heavy fuel oil. Steam from these boilers and from the tin mill house flows into a low pressure system which serves process requirements, heating, etc., in the tin mill, wire mill and tube mills. Boilers in No. 3 house are fired with powdered coal from unit pulverizers, with coke oven gas as an auxiliary. Steam from these boilers is used in the three turbo-generators and as make-up for the low pressure system.

The south mills boilers receive treated water from an intermittent cold process lime-soda softener. No. 3 house, which gets condensate from the turbines, operates with 50 per cent make-up, while the other houses use 100 per cent make-up.

Water consumption of the Aliquippa plant averages about 315,000,000 gal per day — more than 50,000 gal per ton of steel made. Water is pumped from the Ohio River at three pumping stations, passing through trash racks, revolving screens and chlorinating equipment.

The north pump house contains three pumps, one rated at 60,000,000 gal per day, one at 30,000,000 gal per day, and one at 40,000,000 gal per day. The first two are turbine driven, the last motor driven. This house is connected to a large stand pipe by a 48-in. main and to the central pump house by a 60-in. main. The north house furnishes water to the coke plant, blast furnaces, steel works and rolling mills.

The central pump house, which supplies water to the north mills and tube mills, contains seven motor-driven pumps, each rated at 15,000,000 gal per day.

Water for the tin mill and rod and wire mill comes from the south pump house, which contains two 40,000,000 gal per day motor-driven pumps and one turbine-driven pump of 10,000,000 gal per day. There are also three low-head condenser pumps of 40,000,000, 20,000,000 and 33,000,000 gal per day, respectively. These are motor-driven, and supply water only to the surface condensers at the power house.

In addition to the two water softening plants serving the boilers, other treating plants provide water for special processes. Water for cooling rolls of the tin plate cold reduction mill is processed through 18 sand bed filters. Extremely clean, pure water is supplied to the electrolytic tinning lines by a 750-gpm demineralizing plant. In addition, clarified water is obtained from two large reactors in this plant.

With full operations, monthly fuel requirements of the Aliquippa plant, over and above the coke oven gas and blast furnace gas produced in the plant, consists approximately of 37,000 tons of steam coal per month, 1,600,000 gal of fuel oil (of which about 94 per cent goes to the open hearth, 6 per cent to the round and seamless tube mills), and 50,000,000 to 100,000,000 cu ft of natural gas, running to the high side in the winter months.

Natural gas to the extent of 100,000 cfhr may be introduced into the coke gas lines as required. Also, some natural gas may be used directly on certain furnaces as a standby fuel when desired.

A wharf 300 ft long, partially covered by a building with crane service and railroad tracks, facilitates river barge shipment of products.

TABLE XII
New Hot Strip Mill Data

Stand	Length of roll body, in.	Roll diameter, in.		Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll rpm
		Work roll	Back-up roll		Hp	Voltage	Type	Rpm		
Vertical edger	12	38	—	—	(2) 500	440	Synch.	360	16.35	22
Reversing universal	—	42	—	32-0	(2) 3000	700	d-c	40/100	Direct	40/100
No. 1 finisher	44	22½	44	255-2	3000	750	d-c	225/430	6.333	35.6/68.
No. 2 finisher	44	22½	44	18-0	3000	750	d-c	225/430	3.545	63.5/121.
No. 3 finisher	44	22½	44	18-0	3000	750	d-c	90/180	Direct	90/180
No. 4 finisher	44	22½	44	18-0	3000	750	d-c	125/250	Direct	125/250
No. 5 finisher	44	22½	44	18-0	3000	750	d-c	150/300	Direct	150/300
No. 6 finisher	44	22½	44	18-0	3000	750	d-c	200/400	Direct	200/400

EXPANSION

Several projects are under way which will broaden the product mix of the Aliquippa plant and increase the efficiency of some of its present production facilities.

Important among these is a 44-in. semi-continuous hot strip mill, designed to produce tin plate hot bands 0.070 to 0.100 in. thick up to 38 in. wide, barrel stock of No. 18 gage, and skelp for electric weld continuous and buttweld pipe mills ranging 0.103 to 0.337 in. in thickness and 10 to 38 in. in width.

This mill will consist of a vertical edger, a two-high reversing universal rougher and six four-high finishing stands, details of which are given in Table XII. Two mandrel-type down-coilers will be located some 300 ft beyond the last finishing stand. Vertical edgers will be placed ahead of No. 1 finisher and after No. 3 and 5 finishers. A rotary crop shear and descaling pinch rolls will precede the finishing train.

Roller bearings will be applied to all work roll necks, and oil film bearings to the necks of the reversing rougher rolls and all back-up rolls.

Two 75/150-hp mill type motors under adjustable voltage control will operate the mill screws on the roughing stand. Two 75-hp mill type motors will actuate screwdowns on each finishing stand.

Power for the reversing rougher will be provided by a motor-generator set consisting of two 2500-kw, 700-volt d-c generators and one 1400-kw, 500-volt d-c generator driven by an 8500-hp synchronous motor. Finishing stand drives will draw power from two sets, each made up of three 2500-kw, 750-volt d-c generators and one 10,000-hp synchronous motor.

Reversing mill tables, finishing mill approach tables and runout tables will be driven by d-c motors operating under adjustable voltage control.

Slabs entering the mill may range 19 ft 7 in. to 23 ft 6 in. in length, 12½ to 38 in. in width, 4¾ to 7¾ in. in thickness, and 3965 to 15,870 lb in weight. They will be heated in two continuous recuperative furnaces with hearths 86 ft x 26 ft, fired with coke oven gas or fuel oil.

Another important unit in this expansion plan is an electricweld tube mill consisting of nine driven horizontal roll stands, five idler vertical forming stands and three sizing stands.

This mill will produce line pipe in sizes 4 to 12 in. and standard butt welded pipe in 4, 5 and 6 in. sizes. It will receive skelp in coil form 0.237 to 0.330 in. thick and 14½ to 40½ in. wide. Coils will weigh 7930 to 15,800 lb.

The skelp will be cold formed into pipe and welded by a 175,000-amp resistance welder. A high frequency unit will anneal the completed weld. A rotary flying cut-off machine will be located at the mill exit. Other rotary cut-off machines will be provided for cutting, facing, chamfering and reaming. A rotary straightener will accommodate all pipe sizes produced on this mill.

All pipe handling and finishing facilities are designed to handle pipe in lengths up to 60 ft.

Two continuous buttweld pipe mills are also being installed, one designed for the production of ½ to 1½ in. pipe in 21 ft lengths, the other for 1¼ to 4 in. sizes in 21 to 43 ft lengths.

The smaller mill, which is served by a 154 ft 5 in. heating furnace, will consist of a 14-stand forming and welding stands and a 3-stand sizing mill. It is designed for 21-ft lengths.

The larger mill, with a 185-ft heating furnace, will have a 10-stand forming and welding mill and a 3-stand sizing mill.

To provide skelp for these mills, a 42-in. slitter will be installed. This line will consist of a pallet conveyor, a coil car, an expanding mandrel pay-off reel, a five-roll leveler, an up-cut shear, a slitter with scrap chopper, a recoiling reel and another coil car.

This line will be able to handle coils up to 42 in. in width and 20,000 lb in weight of strip 0.100 to 0.276 in. thick. Entry and exit coils will have 24-in. inside diameters, with outside diameters up to 60 in.

The production of seamless tube at Aliquippa will be facilitated by the installation of a stretch reducing mill in connection with the existing No. 2 seamless mill. This new facility is designed to produce principally oil well tubing 2⅜ to 2⅞ in. outside diameter from tubes of a maximum 7-in. outside diameter and 36 ft length.

A gas-fired reheating furnace will be installed ahead of the stretch mill.

The new mill will consist of 16 stands, each driven by a 200-hp motor. The drive motors will receive power from a 1500-kw motor-generator set.

Pipe leaving the stretch mill will be conveyed to new saws and cooling bed, and will then proceed to existing finishing facilities in the seamless department. Some supplemental finishing equipment will be installed here, including a 5-in. upsetter, facing machines, automatic threading machines, storage racks, conveyors, etc.

It is expected that these new facilities will go into operation late in 1956.

EDITOR'S NOTE: *The installation of two oxygen-blown converters, providing an added annual ingot capacity of 300,000 tons, was announced as this went to press.*

By HERMAN C. INLOW, Research Chemist, Cities Service Research and Development Co., East Chicago, Ind.

Roll Neck Lubrication

. . . . spray lubrication is a recent advance in the lubricating art . . . . the number of lubricants can be reduced . . . . increased tonnage and bearing life are also obtained . . . .

▲ LUBRICANTS in steel mills must function under possibly a greater variety of adverse conditions than in any other industry. This paper is concerned only with roll neck lubrication, so a summary of the adverse conditions under which the roll neck lubricant has to operate is given below:

1. Water — a high pressure water spray will contaminate the lubricant and has a tendency to wash the lubricant from the moving parts being lubricated.
2. High temperature — present everywhere hot steel is being processed. The lubricant must be heat resistant.
3. Mill scale contamination — causes abrasive wear when allowed to enter the bearings.
4. Pumpability — the same lubricant must be easily pumped through centralized systems at greatly varying temperatures and through distances up to several hundred feet.

HISTORY

It might be well to review the past history of roll neck lubrication. Tallow was probably the first lubricant used for this purpose; followed next by a block of roll grease. This block grease was used for a considerable period of time. The advantages of automatic lubrication were being realized slowly but surely and ideas were being developed on how to replace the familiar block of roll grease. A hard wooden, hollow block packed with woolen waste, spring loaded and connected into an automatic lubrication system was the first step in this direction. To properly distribute the lubricant the roll bearing was drilled and grease grooves were cut for added application of grease through the bearing. The use of a spray or nozzle method of applying lubricant by injection through an air system to the roll necks was next developed. Assemblies of two or three nozzles as a unit for each roll neck are utilized and have proved very satisfactory in effectively distributing the lubricant.

ROLL NECK GREASE AND ROLL NECK SPRAY OIL

This paper deals mainly with the spray application of roll neck grease and oil. This is the most recent advance in the lubrication of roll necks.

General requirements for spray application lubricants are that they lubricate, that they be water resistant, provide an adhesive film, possess extreme pressure properties and that they be pumpable through a pressure system. The requirements are shown in detail in Table I. The types of mills on which these lubricants find application include: blooming, billet, slabbing, bar and plate. The types of roll neck bearings usually encountered are fabric, bronze, babbitt or combination and segmented.

Plain roll neck bearings usually operate under high pressures, shock loading and are exposed to bad water conditions. Thus in order to lubricate these bearings properly, the lubricant must adhere well to the roll necks and resist being washed off by water.

The laboratory development phase of building a product to meet the requirements of a roll neck lubricant involved the evaluation of mineral oil base stocks, additives of various types to give specific properties to the finished product, and the laboratory testing of selected formulations. As is shown in Table I the properties of the roll neck grease and the roll neck spray oil are very similar and some information gained in the

TABLE I

Roll Neck Lubricants Requirements

	Roll neck grease	Roll neck spray oil
Viscosity, SUS at 210 F	Oil viscosity 75-150	150, 250, 500 750, 1000
Spray retention test, lb, 150, 250, 500	—	40
Retention test, 750,1000	—	Pass
Penetration	NLGI No. 0, 1, 2	—
Drop point, F, min	200	—
Corrosion, Cu	None	None
Timken test, lb, min	20	—
Four ball extreme pressure test weld value, kg, min	150	200
Four ball wear test scar diameter, mm, max	0.6	0.8
Grease mobility test flow, gm per sec	0.1 at 0 F	300 SUS or lower 0.06 at 20 F 300 SUS or above 0.5 at 60 F
Graphite	Present	—
Soap type	Calcium	—

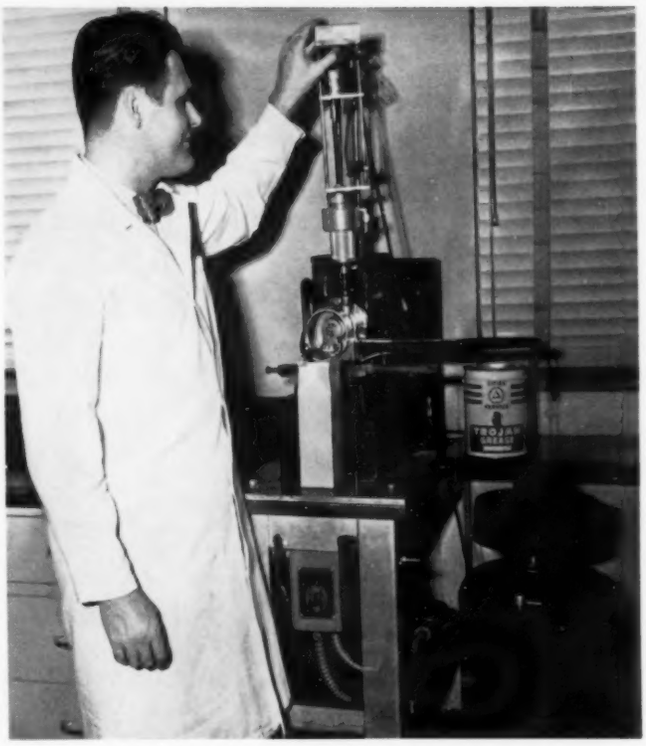


Figure 1 — Grease gun test apparatus.

development and use of the grease was applicable to the oil and vice-versa. The extreme pressure properties are evaluated by three Timken tests — grease gun method, as shown in Figure 1; retention test, as shown in Figure 2; and spray retention test, as shown in Figure 3. The four ball testers for determining extreme pressure properties and friction and wear properties of lubricants were also utilized in the development of the roll neck lubricants. The apparatus is shown in Figure 4, the extreme pressure tester on the left and the wear tester on the right.

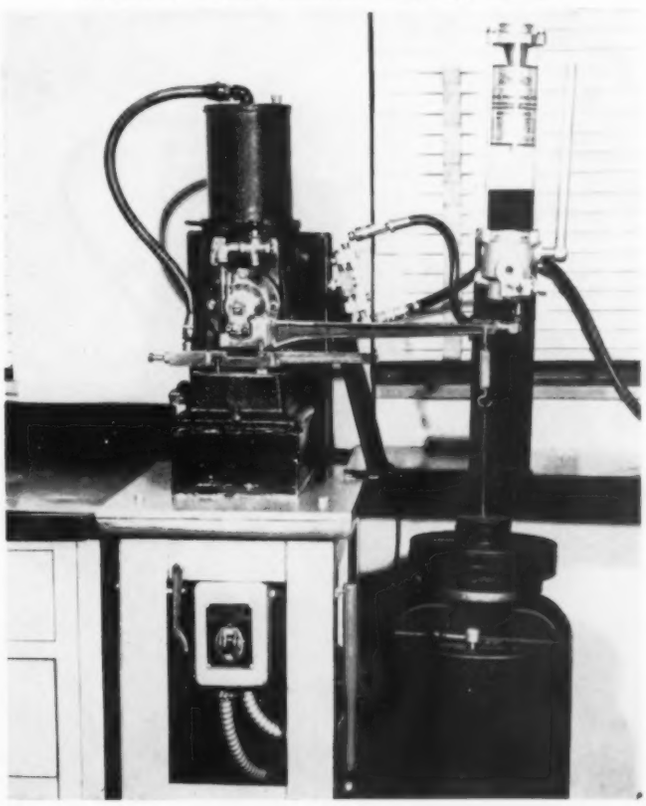
Pumpability is of prime importance and it has been said that even though the grease submitted by any company was the best grease it was possible to make and were supplied free of charge, it would be of absolutely no value unless it could be pumped under the lowest temperature conditions that may be encountered. No lubricant is of any value unless it can be transmitted at the right time to the moving part for which it is intended. Pumpability standards published by technical societies are non-existent. One of the steel corporations has developed its own standards for lubricant pumpability for centralized systems in steel mills. These requirements are shown in Table II. The test procedure and apparatus was developed by this company and has been ably described by J. S. Aarons and R. G. Warren in their paper "Pumpability of Steel Mill Greases." See October, 1954 *Proceedings AISE*. This test procedure was used in our development work both on the grease and on the spray oil. Our apparatus is shown in Figure 5. In actually running the test, the SOD pressure viscosity cylinder is placed inside the cold box shown and then brought to the test temperature.

Lubricants were developed in the laboratory meeting the requirements specified for a roll neck grease and a roll neck spray oil. The next step was a field trial under actual mill operating conditions. Here the experience and cooperation of the customer are indispensable. Through close cooperation of mill personnel and oil company lubrication specialists, significant data are obtained on new product development.

The spray application of lubricant to the roll neck is illustrated in Figure 6. The lubricant to the roll necks is introduced into pneumatic atomizing nozzles mounted on a manifold located a few inches from the neck surface.

Figure 2 — Retention test apparatus.

Figure 3 — Spray retention test apparatus.



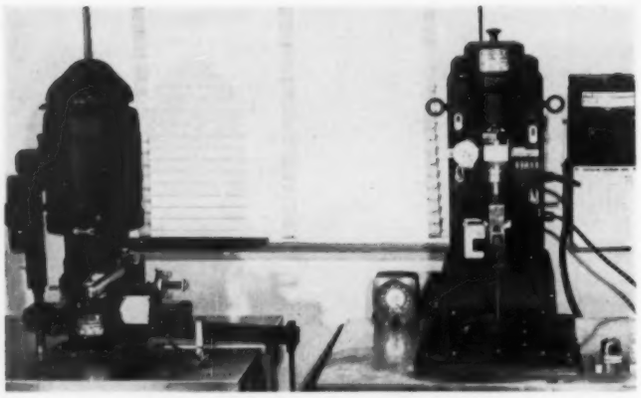


Figure 4 — Four-ball testers were used to develop properties of roll neck lubricants.

The pumping cycle is not continuous. A frequent supply of lubricant to the neck is essential since the wiping action of the bearing and the water washing tends to remove the film of lubricant. The principal reason for installing a spray system is to properly lubricate the thrust surfaces of the roll neck. A segment of the spray, or in one case, a separate nozzle directed against the thrust surface continuously maintained a lubricant film in this area. The use of spray application in roll neck lubrication eliminates the need for groove ports in the high pressure zone, thereby increasing the bearing surface available under maximum rolling pressures. Increased bearing and neck life can be expected through the use of this spray system.

Figure 5 — Pumpability test apparatus.

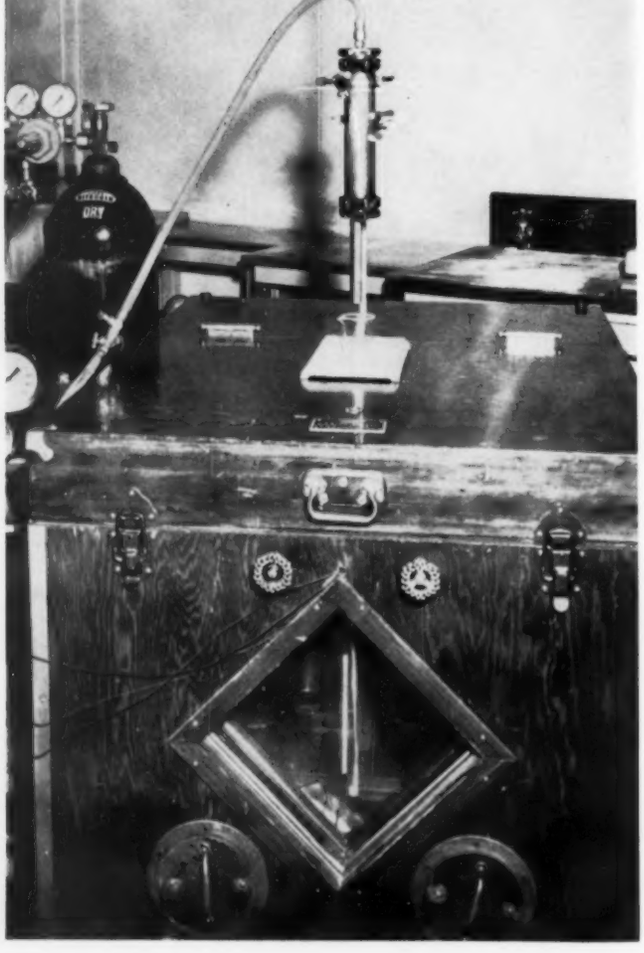


TABLE II

Roll Neck Lubricants Pumpability Requirements

	Roll neck grease	Roll neck spray oil
Pumpability		
Flow rate, gm per sec		
60 F	—	0.5*
20 F	—	0.6**
0 F	0.1	—

*Viscosity grades 500, 750 and 1000 SUS at 210 F.

**Viscosity grades 150, 250 SUS at 210 F.

Roll neck grease was the first product utilized for spray application and was successful. Bearing life was extended five times over the plain application of grease by conventional methods.

Roll neck greases without graphite have been used successfully, however there is noted a certain preference for graphited grease for this application. Graphite seems to help the thin grease film on bearing surfaces resist the washing action of water; also the graphite acts somewhat as a parting material and reduces the tendency toward the galling of bearing surfaces under conditions of boundary lubrication. These conditions are both encountered in plain roll neck bearings where water sprays are used for cooling of the roll necks. Rare instances of excessive wear of the closely fitted and hardened pistons and check valves of the lubricant

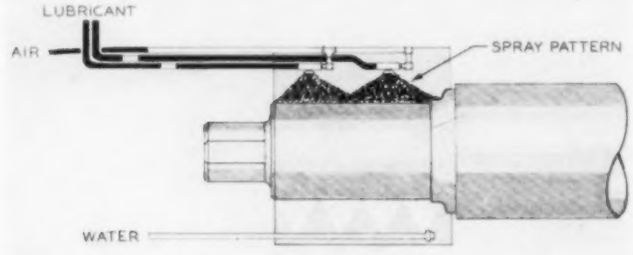


Figure 6 — Top view shows method of spray lubricating roll necks.

pump were noted when graphited grease was being applied to plain roll neck bearings through an automatic centralized system. Attention to the type of graphite used, particularly as to the maximum particle size and the amount and character of the non-graphite material present, can alleviate this problem greatly.

Clogging of the metering device of the lubricator can be caused by outside contamination of the lubricant or possibly by soap grains or lumps present in improperly compounded roll neck grease. These are a matter of proper care, handling and manufacture of the product and rarely become a factor in roll neck lubrication.

Extreme temperatures may cause certain types of calcium soap roll neck grease to separate into its component parts and thus trouble may develop in the lubricators or feed lines. This problem can be eliminated by the proper placement of manifolds, lubricators and feed lines.

The "slumpability" of a grease should also be considered in selecting a product for a centralized system.

Slumpability is the ease with which a lubricating grease will settle in the grease container and is important at the pump suction of the centralized system. A grease with poor slumpability will tend to cavitate and will not feed properly into the pump for the centralized system.

The use of roll neck spray oil has not created any new problems and has eliminated some or the possibility of some, e.g. soap separation in lines, slumpability problems, and the graphite problem.

A further word on application systems would seem to be in order. It is not felt that it is 100 per cent all right to design a grease system and then pattern the grease to fit the system. The first consideration, in our mind, is the need of the bearing itself and the system should be designed with this uppermost in the mind. After the needs of the bearing are satisfied, then the product should be given as good pumpability properties as possible without sacrificing its lubrication characteristics. Certain ideal characteristics of a roll neck lubricant have had to be sacrificed to facilitate the delivery of the lubricant in existing equipment. The lubrication system should be properly designed to deliver the correct lubricant to the bearing.

Mill scale contamination can present a serious problem in roll neck lubrication. The contamination of the lubricant with mill scale or dirt before it enters the centralized system should be avoided. In an effort to eliminate the probability of the scale getting into the bearing, numerous ingenious scale guards have been developed throughout the industry ranging from a sheet metal guard to laminated wooden bearing caps. In one case the spray apparatus was incorporated into the scale guard itself and has proved very successful.

The automatic dispensing equipment should be located in a separate room or cubicle which can be provided with heat for extreme winter conditions. The placement of main feed lines enroute to the mill stand should not be dictated by a path of least resistance with regard to installation, but should be properly placed to insure best operation and maintenance. Valve blocks and manifolds should be checked regularly as should spray nozzles and lines — at least at every bearing or roll change. The pump equipment should be provided with alarm devices so that instantaneous notification will be given of failure.

In installations where the spray application of the roll neck lubricant has been used, it has proved to be of considerable merit. Spray application does not provide all the answers to ideal lubrication of roll necks but it has proved itself worthy of extensive consideration due to very conclusive results of improvement in certain locations. In one outstanding example previously reported, bearing life was increased some five times. From this it is obvious that considerable increased tonnage was realized per bearing change. More recent field trails have shown that bearing life and tonnage are increased even more when roll neck spray oil is used instead of the roll neck grease. Actual tonnage figures are of course not available. With the proper combination of lubricant, spray nozzle and pump timing, the system is the best method known to date for lubricating the open type babbitt bearing.

Additional advantages from the use of these roll neck lubricants have also been noted. The number of lubricants required for mill operation can be reduced in that the roll neck lubricants can also be used for other purposes. The roll neck grease can be utilized for screwdown screw and nut, housing windows, table bearings, and the spindle carrier bearings. The roll neck spray oil can also be used for pinion stand lubrication and enclosed vertical gear sets.

The life of a roll neck is determined also by a number of other factors which are beyond the scope of this paper, but are mentioned below:

1. Operating conditions, i.e. type of steel, reduction per pass, etc.
2. The mechanical design of the bearing itself.
3. The condition of the neck of the roll.
4. The alinement of the mill.
5. The alinement of the bearings to the rolls.
6. The composition of the bearing material.
7. The bond of the bearing material to the bearing shell.
8. The fit of the bearing to the roll neck.

There is no question but that proper lubrication of steel mill equipment is of prime importance in obtaining optimum production of uniform products. New lubrication developments are not evolved over-night; neither are they accomplished by a single party. It is only through the close cooperation of steel mill personnel and oil company lubrication specialists that these developments are perfected.

DISCUSSION

PRESENTED BY

ALFRED A. PAUL, Manager of Services, The Brooks Oil Co., Pittsburgh, Pa.

J. S. AARONS, Lubricants Chemist, National Tube Division, United States Steel Corp., Pittsburgh, Pa.

G. M. Kyle, Assistant Mechanical Superintendent, Inland Steel Co., East Chicago, Ind.

M. W. PATTERSON, Lubrication Engineer, Cities Service Oil Co., Chicago, Ill.

GEORGE H. DAVIS, Lubrication Staff Engineer, Shell Oil Co., New York, N. Y.

Alfred A. Paul: We in our company are most happy to see a leading company like the author's agree with us on spray lubrication of roll necks and bearings. For several years we have advocated this idea and naturally are pleased to see it fostered by other oil companies. We experimented first with the idea among the sugar mill companies in Cuba and this dates back as far as 1949. Success justified gradual introduction of the idea to the steel industry. We would like to emphasize, and believe that most people responsible for maximum roll neck and bearing life will come to agree that cleanliness is of greatest importance. In fact, too much importance cannot be placed on this preparation.

In a correctly applied or installed bearing, the shaft will flow on a film of oil. This film has a so-called wedge shape, being thicker where the oil is dragged in at the lower pressure area between the shaft and the bearing; and thinner at the high pressure area. Friction is at a minimum so long as such an oil film is maintained. The oil performs another important function in carrying away excess heat generated by friction. Some heat is

also dissipated through the shaft, but a larger proportion must be carried away through the bearing and its housing.

Much study has been given in the past years to improving the design of oil grooves. In many cases this resulted in doubling the safe load on the bearing. With roll neck spray lubrication as ably explained by Mr. Inlow, grease grooves can be eliminated — thus a further increase on the safe loading of bearings. Clearance is necessary to allow room for free motion between the shaft and the bearing and for the formation of an oil film. Good clearance in large bearings such as blooming mills and other mills of large construction (and this is subject to criticism) should be from 0.060 to 0.090 in.

Tight fitting scale guards must be held in place at all times. Scale can ruin a bearing and roll neck in a very short time. By keeping this scale problem to the lowest possible degree, greater bearing life will be obtained.

Mention is made of laboratory development work. This appears to unveil the fact that an attempt is being made to introduce laboratory tests which will establish the qualifications needed for hot mill roll neck lubricants. The specification requirements as listed in Table I are somewhat vague — perhaps some of the tests should be explained and the possible reasons for these tests, particularly that of pumpability, spray retention and the retention tests. With the exception of viscosity, penetration, drop point and corrosion test, the author is referring to requirements which in general are not in common use. Some companies and their laboratories place emphasis on the Timken 4-gram test. It might be well to evaluate its merit in conjunction with lubricants adaptable for spray lubrication of roll neck journals and bearings.

With the reference to pumpability, it would seem that close work has been done on the pumpability or mobility test. In a recent conversation with a leading equipment manufacturer, mobility of roll neck lubricants was discussed. They stated that the results obtained in their experimental automatic lubrication system can be better correlated with the work done on the Standard Oil Development Co.'s pressure viscosimeter. This piece of apparatus has fairly wide acceptance for testing the fluidity of greases and heavy oils. ASTM and Federal Government lists this test under the heading of "Apparent Viscosity."

Mr. Inlow has a good point when he stresses the use of a spray system, especially if every effort is made toward proper installation.

The author appears to confine his remarks to calcium soap base greases when commenting on the use of plastic lubricants. We presume this is based on the fact that calcium grease has good water resisting properties and is low in cost.

The mention of slumpability is very desirable as it calls attention to a characteristic of grease which is frequently not given sufficient consideration. The comments stressing the advantages of heavy oils in a spray system when compared with greases is timely and well prepared. We believe the use of oil could be more worthwhile when maximum film thickness is obtained on the bearing surface.

The author mentions contamination and this is extremely essential to any centralized lubricating system. Contamination can and will destroy the value of all development work. Stressing the advantages of using oil as against grease should perhaps be enlarged upon, especially since Mr. Inlow's paper is intended to point the way toward the use of fluid lubricants. To obtain the maximum advantage of spraying fluid lubricants will depend upon close cooperation between the lubricant supplier and engineering and maintenance personnel. The following is indicative of that cooperation:

1. Longer bearing life — Blooming mill roll bearings have been extended from 3 to 18 weeks or as much as one set per four roll changes.
2. Mill lining delays reduced to a minimum. An average of $1000 per minute spent on shutdown. Thousands of dollars saved by reducing delays and downtime.
3. Shop work on bearings cut to a minimum by elimination of machining and grooving.
4. Lubricant consumption is reduced from one drum per working turn (that is some 20 drums per week) to three drums per week. Every ounce of lubricant utilized — spraying some 45 or 48 seconds every two minutes.
5. Roll necks no longer need the constant finishing or dressing.

In conclusion, it is our opinion the main reason for success in spraying a fluid lubricant with a heavy viscous oil is that it carries the load better than a thin oil which is used in available roll neck greases. Pumpability is important, and fluid lubricants substitute heavier viscosity for soaps. In other words, the film thickness is increased with fluids and this is helpful. Proper fluid lubricants sprayed on roll necks and bearings assures a film, which being an oil, reduces to a bare minimum the potential of scale build up, therefore, gives the water an opportunity to wash the scale out much easier than with greases.

Mr. Inlow's closing remarks are very good, for cooperation is of prime importance to all concerned. We all strive for the maximum in production and this can only be obtained through such cooperation of steel mill personnel and oil company lubrication specialists.

J. S. Aarons: Mr. Inlow's excellent paper has pointed up one phase, among others, in the formulation of a lubricant which is particularly significant to me. This is the friendly and active cooperation which must exist between the supplier and the consumer at the various technical levels. Finding laboratory tests that will correlate with mill practice, and then using those tests as a measure of control in the development of lubricants offers a challenge which in all too few cases is satisfactorily met. From the consumer's standpoint, the laboratory, by developing new ways of testing, serves a two-fold purpose. On the one hand, it aims to effectively screen those products which prove inferior and which could be a source of trouble if given a field trial without preliminary laboratory testing, and on the other hand, it can indicate to the supplier the properties that are necessary to pass performance benchmarks which are established by certain functional tests and which attempt to correlate as closely as possible with mill procedure. It is indeed gratifying to know that help has been given however small our part.

The spray retention test has been mentioned as one of the tests used to determine the extreme pressure

properties of the spray oil and it may be well to describe the test in detail.

The apparatus consists of:

1. Timken machine and mechanical loader with the oil feed spout positioned to the left side of the cup bearing so that water coming from the reservoir at full flow will be delivered above the point where the cup meets the block.
2. A Trabon hand pump, Model No. KM-3P, a spray block No. 10490, and ¼ in. J spray nozzle. The spray feed block is placed on the right side of the Timken cup bearing with the orifice of the feeder 5 to 6 in. from the cup. The plane of spray is 15 degrees off of vertical.
3. A compressed air supply capable of delivering 60-80 psi of air.

Procedure — Sufficient sample is placed in the Trabon pump reservoir to maintain a level of lubricant above the rack and pinion assembly. Two liters of tap water at room temperature are placed in the Timken machine reservoir.

A thin coating of the test sample is applied to the properly cleaned test cup and block, and the lever arm and block holder are placed in position. The Timken machine is started, two shots of the test sample are delivered to the cup from the pump and spray assembly before the load is applied. The mechanical loader is then started and when the selected load has been fully applied to the lever arm, the stop watch is started. After one minute, a shot of lubricant is applied and at the 1½ minute mark the water is turned on full flow. At the two-minute mark another shot is delivered. At this point the desired spray frequency is maintained until the 15-minute mark is reached. This spray frequency may be one shot per 1, 2 or 4 minutes.

The block and cup are then inspected for O.K. or failure scars. It might be interesting to note that with a 250 in. SSU at 210 F, the total amount of oil coming from the orifice is 2.36 grams per shot. Since the spray creates a three foot pattern, only 7 per cent of the shot hits the Timken cup, which amounts to 0.17 grams. Needless to say, an adequate metal guard covering the working parts of the machine should be employed when running the test.

G. M. Kyle: I would like to ask the author about the physical location of the oil sprays on an enclosed sleeve-type babbitt bearing, and the open type half bearing?

M. W. Patterson: All of our work has been done on half bearings, and in these applications the oil sprays were located 45 degrees from the vertical on the open side of the neck.

George H. Davis: I would like to know if there has been any work done on other than steel on steel as shown on your Timken. After all, you are working with babbitt or bronze on steel. Has any work been done to evaluate the products in that respect?

Herman C. Inlow: Not in conjunction with the roll neck spray oil or grease. It certainly is a field that should be investigated. There are available other types of material that could well be investigated with these lubricants, but as of this date, we have not done so.

One of the problems that is closest to my heart, being a laboratory man, is the correlation between laboratory tests and field performance in the steel mills. That certainly is a wide-open field. The laboratory tests that I brought to your attention in my paper are the ones that we feel are the most applicable to giving us a correlation between laboratory and mill practice. We hope for the development of better test procedures because we realize that these are not 100 per cent perfect. It is the constant aim of the laboratory man to find evaluation tests that will indicate how the lubricant is going to perform in actual operation.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC. OF

IRON AND STEEL ENGINEER

(Required by the Acts of Congress of August 24, 1912, March 3, 1933 and July 2, 1946)

Name of Publication: *Iron and Steel Engineer*, published monthly at Pittsburgh, Pennsylvania. (Report of October 1, 1955.)

State of Pennsylvania

County of Allegheny

Before me, a notary public in and for the State and County aforesaid, personally appeared T. J. Ess, who, having been duly sworn according to law, deposes and says that he is the editor of the *Iron and Steel Engineer* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933 and July 2, 1946, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

Editor: T. J. Ess, 1010 Empire Building, Pittsburgh, Pennsylvania.

Managing Editor: None.

Business Manager: None.

2. That the owner is: Association of Iron and Steel Engineers, 1010 Empire Building, Pittsburgh, Pennsylvania.

No Stockholders.

BOARD OF DIRECTORS

1955

President, JOHN H. VOHR, *General Superintendent*, United States Steel Corp., Gary Steel Works, Gary, Ind.

First Vice President, W. H. COLLISON, *Plant Superintendent*, Blast Furnaces and Coke Works, Great Lakes Steel Corp., Ecorse, Mich.

Second Vice President, J. D. O'ROARK, *Assistant Manager, Department of Service & Maintenance Electric*, Weirton Steel Co., Weirton, W. Va.

Treasurer, LEONARD LARSON, *Chief Engineer*, Republic Steel Corp., Cleveland, Ohio.

Secretary, EMIL KERN, *Vice President in Charge of Engineering*, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

Past President, J. L. YOUNG, *Vice President, Engineering*, United States Steel Corp., Pittsburgh, Pa.

Past President, E. L. ANDERSON, *Superintendent, Electrical Department*, Bethlehem Steel Co., Johnstown, Pa.

Honorary Director, JAMES FARRINGTON, Steubenville, Ohio.

Honorary Director, L. F. COFFIN, *Assistant General Manager*, Bethlehem Steel Co., Sparrows Point, Md.

Director-at-Large, S. C. READ, *Director, Construction and Maintenance*, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Directors: G. J. GOCKSTETTER, *Chief Combustion Engineer*, Republic Steel Corp., Chicago, Ill.

T. M. FAIRCHILD, *Assistant to General Manager*, Bethlehem Steel Co., Johnstown, Pa.

A. M. CAMERON, *Superintendent Rolling Mill*, Atlas Steels Limited, Welland, Ontario, Canada.

D. E. WHITEHEAD, *General Lubrication Engineer*, Crucible Steel Co. of America, Pittsburgh, Pa.

H. L. JENTER, *Manager of Operations, Cleveland District*, American Steel & Wire Division, United States Steel Corp., Cleveland, Ohio.

PAUL E. LINDBERG, JR., *Superintendent of the Hot Metal Division*, McLouth Steel Corp., Trenton, Mich.

JOHN A. FERGUSON, *Electrical Engineer*, Republic Steel Corp., Youngstown District, Youngstown, Ohio.

E. C. HITE, *Assistant Superintendent of Maintenance*, Timken Roller Bearing Co., Steel and Tube Division, Canton, Ohio.

C. G. HOGBERG, *Assistant Chairman—Operating Committees*, United States Steel Corp., Pittsburgh, Pa.

E. F. DONATIC, *Assistant General Superintendent, Service Division*, Kaiser Steel Corp., Fontana, Calif.

C. S. CASSELS, *Chief Project Engineer*, Henry Disston & Sons, Inc., Philadelphia, Pa.

C. L. SQUIER, *Assistant to Superintendent, Electrical Department*, Bethlehem Steel Co., Lackawanna, N. Y.

L. A. TERRY, *Superintendent, Power and Electric Department*, National Tube Division, United States Steel Corp., Gary, Ind.

K. R. DANIEL, *Chief Engineer and Vice President*, American Cast Iron Pipe Co., Birmingham, Ala.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

T. J. ESS, Editor.

Sworn to and subscribed before me this 7th day of October, 1955.

ALMA A. JORDAN, Notary Public

(My commission expires January 5, 1959.)

Modernization of 84-in Plate Mill at Alan Wood Steel Co.

By THOMAS H. WILLIAMS
Assistant Chief Engineer
Alan Wood Steel Co.
Conshohocken, Pa.

. . . . modernization of Alan Wood's 84-in. plate mill with installation of new rotary heating furnace required a complete mill shutdown only from August 7 to September 1 . . . . careful planning and scheduling plus advance work on weekends when the mill was down for regular scheduled maintenance kept loss of production to a minimum . . . .

▲ FOR the past ten years, Alan Wood Steel Co. has been increasingly aware of the need for improvements in its 84-in. plate mill, both for betterment of product and material handling.

The mill was installed forty years ago, in 1914. During this period, the only major changes to date consisted of improved slab heating by installing modern type preheating checker chambers, and increasing the horsepower on the drives for the roughing and finishing stands. The designers of two generations ago should be commended for an installation that has produced a good product for so many years.

Present day market studies, fitted to our mill capacity dictated certain limits for plate thicknesses and widths which would be most economical for the combination of new equipment being considered, and the use of existing facilities. With the above ideas in mind, a description of the original installation is presented now, for comparison with the new installation.

OUTLINE OF ORIGINAL PLATE MILL PRIOR TO AUGUST 1, 1954

Slab ingots ranging from 1300 to 6500 lb were cast in the open hearth and transported via a narrow gage railroad to the preparation yard at the furnace end of the plate mill department. Slabs, rolled in the blooming mill, were transferred 75 ft to the same area by overhead crane and cable-operated narrow gage railroad buggies.

After stock piling, scarfing, etc., slabs were again transferred to narrow gage buggies by overhead magnet and tong-handling cranes, and pushed into the furnace section. Here, two overhead rotating five-ton cranes charged them into six side door reheating furnaces, with operating capacity of approximately 100 tons heating or 33 tons charged weight per hour.

These cranes also discharged the hot steel to a roller table, central with the furnaces, feeding the three-high roughing stand, known as the "Conshohocken Mill," and on to the same type finishing stand, each mill being driven by 2500-hp motors (which were converted from 1600 hp in 1945 with a change of electrical characteristics from 25 cycle to 60 cycle, by replacing stators and rotors and coil changes).

Leaving the mill, plates were hot leveled and entered a cooling bed and laying out area, thence into the shearing line of three hydraulic shears; one end crop and two side shears, each with an alligator scrap shear.

The plate flow from the shear area was across a transfer table to the shipping aisle of the building,

Figure 1 — Overhead rotating 5-ton cranes charge slabs into side door furnaces in the old mill setup.

weighed, and by tilt devices deposited on the floor for distribution by magnet overhead cranes. Plates requiring resquaring or rejects were taken from the line following the final shears in the area at the end of the building, in the shearing aisle.

With the above operations, the three turns required a total of 281 men, with 95 men on day and 93 men on each night turn.

NEW EQUIPMENT AND LAYOUT AS INSTALLED—1954

The following description will present the modernized version of the mill, and several of the factors considered in its installation.

The final results of a study of the above mill indicated a more favorable economic balance would be obtained by the elimination of cast slab ingots and the sole use of rolled slabs from the blooming mill.

The increased width of slabs desired, required additional and wider crane-tong facilities with a maximum jaw opening of 32 in., affecting both the blooming mill and slab yard cranes. One new trolley, with tongs, and a traveling cage was installed on the existing slab yard magnet crane, requiring a new bridge girder to support the side-overhung load of the trolley on the bridge.

Through use of the above facilities, the narrow gage track system for handling slabs was eliminated, including a 50-ton diesel locomotive.

Approximately 50 per cent of the existing slab yard was enclosed to provide a protected area over the site of a new scarfing crane. It is of the semi-gantry magnet type, a duplicate of the crane now in use in the hot strip mill slab scarfing yard. This crane depiles, distributes and turns slabs over an area 35 ft × 99 ft, repiling the slabs after the surface preparation has been completed. The two previous mentioned tong-cranes service the slab and scarfing yard. The new tong crane removes the prepared slabs to a small overhead crane with a fixed trolley equipped with magnets. This crane is used to deposit the slabs on the pallet-chain reversing conveyor transporting the slabs to the rotary furnace. It is to be noted the slabs from the tong crane are placed with one end against a plate bumper, to maintain the end of the slab next to the furnace in a constant position. Spacing of the slabs for side distance can be variable depending upon the speed of operations, the conveyor being stopped by limit switch for a final position under the charging peel. This conveyor has five strands, a speed of 10 fpm, being 85 ft from head to tail sprocket, with take-up bearing features.

The charge and discharge mechanism for the furnace presented interesting problems due to the variables previously mentioned. The equipment as finally installed includes a charging and discharging bar with a fixed jaw at the outer face, and a movable jaw, hydraulically operated, for closure to grip the slab. The bar is automatically raised 12¼ in. through a cam actuated by a hydraulic powered cylinder. The racking into and out of the furnace through a travel of 19 ft is accomplished by an electrically driven trolley. The charging bar is water cooled, also the discharge bar, which is a duplicate installation operating in reverse cycles in respect to the steel on the hearth. Both bars are timed position-wise for the slabs placed on the hearth and can charge up to 75 pieces per hour. Each

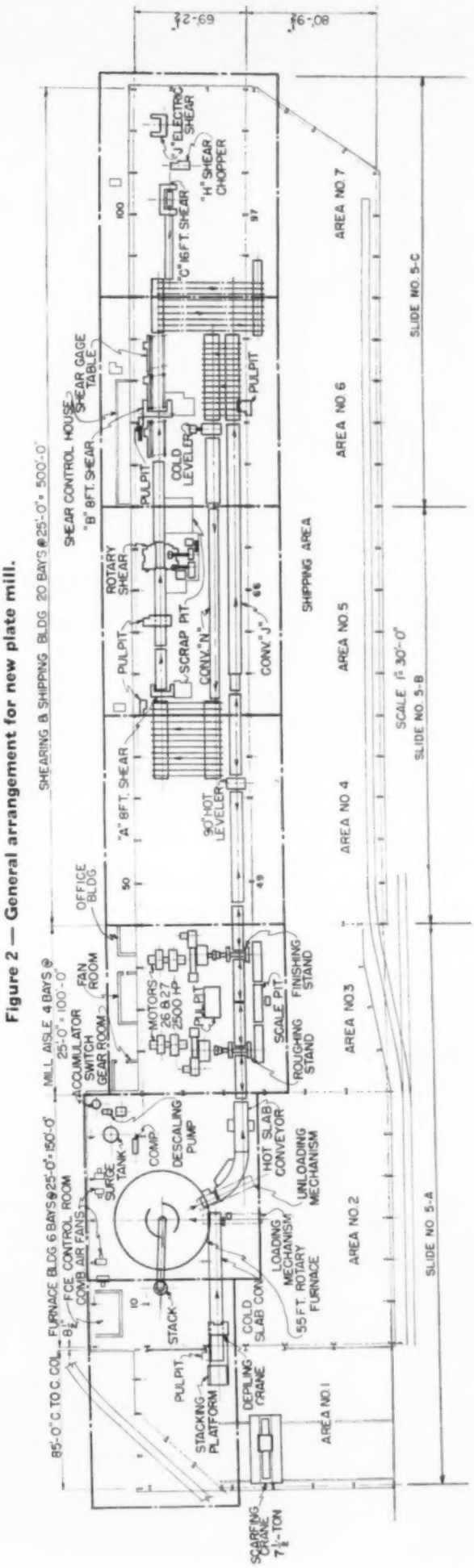


Figure 2 — General arrangement for new plate mill.

charging and discharging machine can be either manually or automatically operated from a pulpit located about twenty feet distant from the furnace doors and between the two machines.

Slabs discharged from the furnace are deposited on a curved table with individual, motor driven, heavy disc rollers closely spaced, with room for scale cleanout under the table. After making the 157 degree turn, a conventional slab roller table conveys the hot steel to the tilting feed table equipped with new sideguards for positioning slabs before entering the mill. The discharge tilt table was not equipped with sideguards at this time, since turning of the slab occurs at this point.

Plate straighteners — Light sideguards have been installed on both tilt tables at the finishing stand, being used especially for floor plate pattern. Electrically powered, the sideguards operate as a pair on each table, having a minimum opening of 30 in. and a maximum of 78 in.

Descaling system — Descaling sprays were installed on the exit side of the roughing stand, and on one side of the finishing stand. The operation of the system is controlled by the table operator located in the pulpit. Mill scale from this operation is removed from the trenches under the tables and mill stands, by a high pressure jet system, being accumulated in a reservoir under the mill floor and removed at intervals with a bucket and overhead crane. The water is retained for a 7-minute retention period to remove the scale by sedimentation, and thence into the recirculating water treatment plant.

Hot roller leveler — The approach table to the existing hot roller leveler has been equipped with light adjustable plate straighteners to improve the work of the 8 × 90-in. leveler which was completely reconditioned.

Plates leaving the leveler are transported by a chain roller conveyor of four strands, acting as a cooling bed, the chain having a speed of 50 fpm, and the plate traveling at a speed of 100 fpm to a transfer table, where the direction of travel is reversed and the plate returns on a roller table to a new backed-up cold roller leveler.

Cold roller leveler — In order to obtain an improved flatness condition in the product, a 6½ × 84-in. backed-up roller leveler was installed. It is driven by a 150-hp a-c motor, and controlled by an operator located 25 ft distant, who also controls all the conveyors, transfer and roller tables from the hot leveler area to the transfer table beyond the layout area. One pass is usually sufficient to attain the desired surface condition of the plates, which range in thickness from ⅛ in. to ½ in., all over ½ in. to 1 in. thickness are dummy-passed through the leveler.

After the leveler, the plate travels over a rebuilt roller table and about 200 ft of a chain roller conveyor, which is used as a layout and plate size identification area. Actual work required of the layout men has been greatly reduced and fewer men are required.

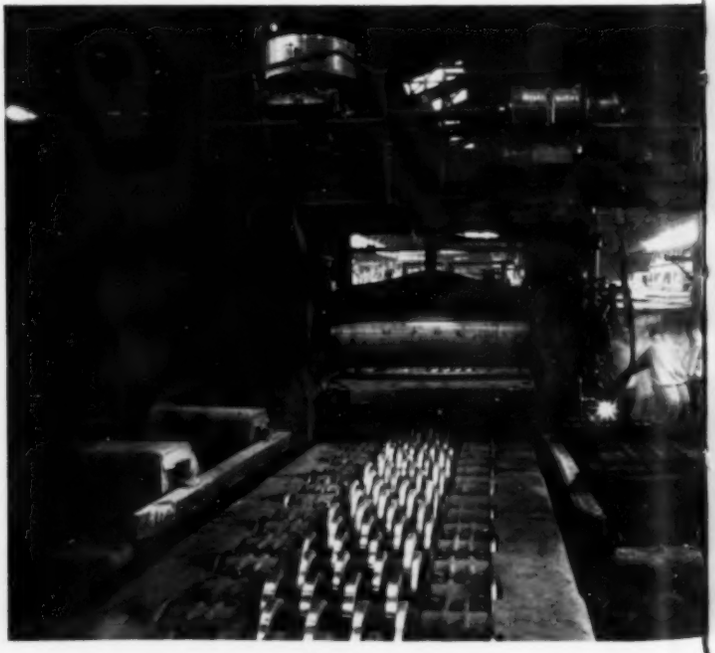
From the layout area, the plate is again transferred at right angles to the conveyor feeding the shearing line.

Shear line — End crop shear "A" — As the plate reaches its lateral limit of travel, it is squared with the shear line conveyor by bumping against a side guard and thence moved forward by roller table to one of the original hydraulic 90-in. shears. Here occurs both front and rear end cropping of the plate, delivering onto a new tilt table. By inter connecting the hydraulic system, as the shear head reaches the plate, the table is automatically depressed, eliminating the down thrust on the receiving table.

Disposal of the crop end scrap presented some problems, the major one being the rear crop end, which due to a bottom block width of 9½ in. plus a distance of 38½ in. from the center line of the last roller on the feed table, failed to feed through to the scrap chute. Pushing this piece forward by the next oncoming plate would work at times, but the plate would either pass over or under the crop end at intervals. To overcome this condition, a short chain conveyor with 7 strands on

Figure 3 — Plate is seen leaving rotary hearth furnace on conveyor which consists of a round section followed by a straight section.

Figure 4 — Light side guards installed on both tilt tables open from 30 to 48 in.



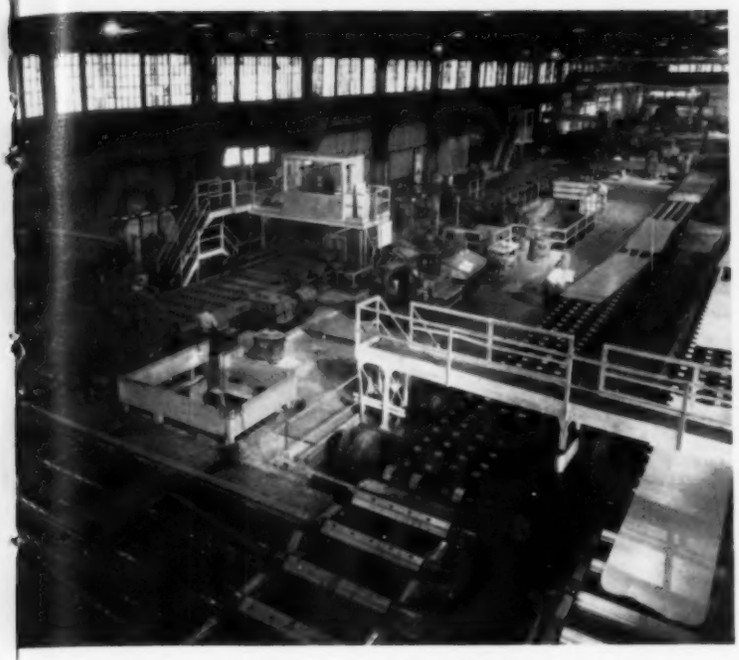


Figure 5—View shows new shearing line and layout areas.

Figure 6 — Exit side of new rotary shear.

12-in. centers was installed, driven by an individual 1½-hp motor, with the added feature of raising this chain conveyor, through air-operated solenoid-controlled cylinders. Scrap ends of 12 in. or less remain on the cylinders. Scrap ends of 12 in. or less remain on the lower knife block, but having a good level surface for support, are easily nudged past the knife and fall into the chute to a scrap box pit, which is 13 ft below the operating floor. Previous to this installation, two men guided or placed the scrap in charging boxes located at the end of the depressing table and the next roller conveyor. This required frequent changing of boxes. One operator now controls the plate from the layout area, over the transfer and the shear to beyond the depressing table. The operator's pulpit is located on the entry side of the shear, the control cabinet being 5 ft from the center of the shearing line, 4 ft-8 in. from the shear knife and 7 ft-4 in. above the pass line, providing the operator a good oblique view of the entire operation, and also of the whole shear area.

Rotary shears — After end cropping, the plate is conveyed to the approach table for the rotary shear where the operator, after noting the width for finishing and thickness of the plate involved, sets the two side cropping, rotating shear knives for the required width and thickness of plate by controls in the pulpit. These settings are registered on indicating dials at the shear proper. The pulpit for this shear is set over the top of the approach table, about twenty feet from the center line of the shear, the operator having a complete view of the plate as it leaves the preceding end crop shear at his back, up to the skew table feeding the cut-to-length shear.

The operator is required to position the plates before entering the shears, which have one fixed knife, on the left facing the entry side, and one adjustable knife. Variations in the side scrap width require manipulating the plate to attain a movement forward at right angles to the axial center line of the shears. Three magnets on the right side of the approach table with a side movement only are used to position the plate with a reference angle piece which indicates the position of the fixed knife edge extended along the entire length of the table, two magnets being placed near the shears to handle short plates and one being 30 ft from the shears to position long plates.

After the plates are positioned, which usually takes approximately 10 seconds, a traveling magnet, mounted on the left side of the approach table and moving in fixed guides, grips the plate and propels it forward a few feet where it enters the shear knives, and travels forward with the plate until the end of the plate approaches the knives, when the magnet is deenergized and returns to its original pick-up position.

Two rocker type crop shears cut the side scrap into 14-in. pieces, thence through gravity chutes, it is deposited into one of two boxes in a pit 28 ft below the floor level, being diverted into either box through means of a flapper type electrically operated gate set in the discharge chute. Emptying of the scrap boxes is accomplished through use of the overhead 10-ton crane, to a railroad car.

After side shearing, the plate is conveyed by new roller tables to the final cut-to-length hydraulic shear.

Hydraulic shear "B" — A skewed-type roller table, equipped with one set of stationary sideguards and a set of adjustable sideguards, is used to position the plate at 90 degrees to the shear knife. However, these sideguards are seldom required since the feed table has rollers skewed to thrust the plate against the stationary sideguard automatically positioning the plate, except in cases of the longest plates, in which case the skew table does not have enough length to affect the entire plate.

A resquare short end cut is made on all plates here, the plate passing through to a skewed roller table, with overhead gage for cut-to-length sizing.

Functioning of the tables, shear and gage is controlled by an operator located on the entry side of the shears. This pulpit, in an elevated position, provides the operator with a good view of the area under his control with the exception of the indicator on the plate gage.

By use of synchronized small electric motors (commonly known as servo motors) the indicator readings are simultaneously shown to a fraction of an inch on a gage mounted in the pulpit.

End scrap is handled in a similar manner to that at shear "A," through gravity discharge chutes to a box for disposal by overhead crane. A six-strand chain conveyor 2 ft-8 in. long with an air cylinder lifting device was installed next to the bottom knife block for disposal of scrap ends.

Hold-downs, hydraulically operated, were installed on each of the end shears, along with new hydraulically-actuated control systems (installed in pairs) for the operation of the shears, depressing table, and hold-downs.

Tables and transfers — A new runout table (roller-type) was installed beyond the shears to deliver plates to the transfer table, which was lengthened and a new drive unit installed. The transfer conveys the plate transversely across the building aisle to the shipping department where, after being weighed, it is kicked-off the roller tables at various designated points for piling. or loading into railroad cars and trucks.

COMMENTS ON CONSTRUCTION

The original plans proposed a minimum length of time for a complete mill shutdown, therefore a schedule was arranged by the engineering department in cooperation with the maintenance and operating departments to provide accessibility to certain areas by construction forces of both outside contractors and maintenance department. Weekend shutdowns were utilized to their fullest extent, all excavated areas being temporarily covered or safeguards erected to permit full operation of the mill at time of start-up. This work was started in February 1954, and through the cooperation of the mill men, production was maintained until No. 5 slab heating furnace was taken out, followed by No. 6 and on August 7, a complete mill shutdown as per revised schedule.

Figure 7 — Skew type roller table is used to position plate at 90 degrees to the shear knife.

At this time, the contractors' force increased from an average of 25 men to 214, while the maintenance department, utilizing men from the regular plate mill operation crews, had a work force of approximately 60 men on a 10 and 12-hr, two turns per day, and a seven-day work week.

For a person not familiar with the many and varied details of construction work of this type, it presented a confused picture of old equipment (to be reinstalled), new equipment, holes in the ground, excavated material, etc., with men working over, under and around each other, not to mention the earth handling equipment, cranes, compressors, etc., occupying any flat open area.

Due to the fine coordination of planning, and the wonderful cooperation of all involved, the first slab was charged on September 1, at 7:25 am starting the final phase of the project.

As in all new major installations the training of operating personnel, adjustments to new equipment, and the acclimating of all the operators to a new job, has taken its toll of tonnage production during the succeeding months, but overall production is now approaching the predicted estimates. The final operating force for the modernized plate mill totals 166.

DISCUSSION

PRESENTED BY

MARVIN WHITMORE, Assistant Master Mechanic, Rolling Mills, Bethlehem Steel Co., Sparrows Point, Md.

F. W. WAGNER, Superintendent Plate Mills, Bethlehem Steel Co., Sparrows Point, Md.

L. F. COFFIN, Assistant General Manager, Bethlehem Steel Co., Sparrows Point, Md.

ROBERT McMICHAEL, Supervisor 206-in. Mill, Lukens Steel Co., Coatesville, Pa.

THOMAS H. WILLIAMS, Assistant Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

C. E. PRITCHARD, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

Marvin Whitmore: Mr. Williams speaks of weekend shutdowns. I would like to know approximately how many shutdowns there were, and of what time duration each, preliminary to the major portion of the work. Also I would be interested in knowing the maximum thickness of plate that it is practical to shear with the rotary side shears.

F. W. Wagner: No inspection table was shown prior to the layout floor. On conditioned steel (by scarfing), can this operation be eliminated?

Mention was made of the reduced amount of laying out operations. Does a reduction in force result from this reduced operation?

Plates are cropped before going to rotary shears. Is it necessary to crop the back end prior to cutting to length?

When cambered plates are encountered at layout floor, how are such plates handled at the rotary shears?

L. F. Coffin: I would like to ask about the location of the levelers; why it is necessary to have two levelers

Figure 8 — During construction, work presented a confused picture of old and dismantled equipment, new equipment, excavations and miscellaneous equipment scattered throughout the area.

in the first place, and why is the second leveler so far away?

Robert C. McMichael: How did you make out shearing your floor plate on the rotary shear?

What is your experience to date with the scrap choppers on the rotary shear?

Thomas H. Williams: Mr. Whitmore, we did not actually schedule any shutdowns for the preliminary construction work. We utilized the normal weekend shutdown and performed other work during the week which would not interfere with the mill operations. Certain inconveniences were amiably tolerated by the operation crews, but it was all in the spirit of cooperation.

The maximum thickness possible to shear on the rotary side shears is $\frac{3}{4}$ in., in accordance with the specifications submitted by Alan Wood.

C. E. Pritchard: We cut up-to and including $\frac{3}{4}$ in. plate on the rotary shears. Above $\frac{3}{4}$ in. is transferred to a shearing area located at the end of the building, where we cut up to 1 in. plate on a hydraulic shear and $\frac{5}{8}$ in. plate on an electric shear.

Thomas H. Williams: The scarfing, or conditioning, of our steel does, of course, produce an improved product. We have not practiced inspection of the plates prior to the layout area. However, a cursory inspection is made at the layout area.

C. E. Pritchard: We do not turn the plate over during the process of bringing it through the layout area. We provide inspection prior to transfer of the plate to the shipping department. The chief inspector works on the shipping floor and personally makes a cross-check inspection during the process of preparing the plates for shipping. If the order calls for stamping and marking on the bottom of the plate, it is turned over at the shipping area and the markings applied.

Thomas H. Williams: The reduction in layout operations did result in a slight reduction in number of men required for the 3 turns. It can be appreciated less work is involved if the layerout is only required to check for overall length and indicate the amount of end crop required to allow for the number of short plates to be cut from the long plate off the mill, and center the plate with side markings to equalize the side scrap to be removed at the rotary shears.

Cropping of the back end of the plate is practiced at our mill. Uneven end crops can create some problem at the rotary shear, especially with one side of the plate being in the grip of the side shear and the opposite plate side free. The end scrap must, of course, be removed, and this extra shearing does not appear to delay production.

C. E. Pritchard: It also helps the scrap handling operation by preparing suitable charging box sized scrap which is transferred by means of a railroad car to the open hearth department.

Thomas H. Williams: The camber in the plate, when encountered, is noted by the layout men and marking lines placed to provide full plate sizing. If camber proves excessive, the plate is sheared at the middle to permit as much recovery of finished plate size as possible. Mr. Coffin's question on why two levelers and their relative locations, can be answered as follows: The hot roller leveler is a part of the original mill installation, and for many years produced a product acceptable to the trade within certain gages. The demand for heavier gages and more rigid specifications by the customer made it mandatory that the product produced at Alan Wood conform to the trade requirements. Therefore, we installed this cold leveler at a site following the cooling bed, prior to the layout area, where it was agreed the plate coolness was sufficient to take care of heat corrections in the surface condition of the plate.

C. E. Pritchard: We roll gages of pattern floor plate down to 6.15 pounds which is approximately $\frac{1}{8}$ in. in thickness. In the transfer of this light gage material from the hot leveler to the layout area we found that there is a tendency for it to develop a little wavy condition that we could take out with the cold leveler. The general flatness of our plate has been considerably improved in this manner.

Thomas H. Williams: The question by Mr. McMichael regarding our results on the shearing of floor plate can best be answered by stating that the superdiamond plate has not produced any undue problems to date; versus plain plate. Certainly more care must be exercised in the layout area due to the diamond pattern, and the shear man tries to adhere very closely to the layout lines to produce a sheared edge parallel to the diamond pattern.

Certain difficulties have been experienced on the scrap choppers, but it would be difficult to pinpoint the trouble or ascribe it to either floor or plain plate. Knife condition, constant changes in width and gage thickness, etc., may be a contributing factor. We are taking certain remedial measurements to eliminate the small outage time being encountered and progress is being made to overcome this problem.

C. E. Pritchard: We have not had enough experience to prognosticate what the future has in store. We have been attempting to develop a change period for the chopper knives commensurate with good operating practice. At present we have been setting up a program to check and change the knives during roll changes, mill delay or lunch period.

By F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

Application of Rotary Hearth Furnace for Heating Plate Mill Slabs

. . . . this paper describes the first installation in this country which uses a rotary hearth furnace for heating slabs . . . . unit is meeting expectations . . . . if the job were to be done all over again, the only possible change might be the selection of a larger unit to reduce scheduling problems at perhaps a slight cost in heating efficiency . . . .

▲ DURING 1952 and 1953 a study was made at The Alan Wood Steel Co. covering the entire manufacturing operation for the production of steel plate, from the open hearth to final inspection and shipping. This study led to recommendations for a modernization program which was completed in September 1954.

The program, as approved, took advantage of a new blooming mill stand which was installed during 1953, in that it eliminated the slab type ingot, substituting slabs from the blooming mill for plate production.

From the many surveys which were made it became apparent that if full advantage were to be realized from the use of rolled slabs, improvements in heating for rolling would also have to be included as part of the modernizing. The heating portion of this program is the subject of this paper.

This discussion is divided into three parts. This is mentioned here, because the first part, which covers the study seems to be more about heating than with a rotary furnace, which the title of this paper would indicate. The second section will cover a description of the furnace and auxiliaries at Alan Wood and, the third part concludes with various problems encountered in operation and general results being obtained with the installation.

The Alan Wood mill consists of a 3-high, 84-in. roughing stand and a 3-high 84-in. finishing stand, each with tilting tables and each driven by a 2500-hp motor with a roll speed of 500 and 555 fpm. Plate produced ranges from ⅛ to 1 in. thick and up to 72 in. wide, both in plain and in pattern floor plate. Due to mill spacing limitations, the longest plate normally produced is 420 in. although this can be increased to 480 in. on special order.

As a result of these lengths, slab weights vary over a wide range — 500 to 5000 lb.

At the time the study was being made, heating was done in six side door batch type furnaces, four regenerative and two recuperative type arranged as shown in Figure 1. Slabs were loaded in the slab yard by means of a magnet crane onto narrow gage buggies for delivery into the furnace building. Charging and discharging were then handled by overhead crane type chargers, with heated slab being placed on a roller table for delivery to the mill.

The heating capacity of these furnaces was about 33 tons per hour total, with a fuel consumption of 22 gal per net ton. The crew consisted of:

Locomotive engineer	(1)
Locomotive brakeman	(1)
Crane operator slab yard	(1)
Crane runner slab yard	(1)
Charger operator	(2)
Door boy	(1)
Heaters	(2)

This is a total of nine men.

Based on this heating rate, as well as time studies of the number of pieces which could be handled by the mill, a preliminary figure of 50 tons and/or 75 pieces per hour was set for new furnace capacity, and various types of continuous furnaces were investigated, with little or no consideration being given to the batch type such as was in use.

A few of the desired heating improvements were:

1. More uniform heating.
2. Lower scale loss.
3. Improved fuel rate.
4. Lower maintenance costs.

Preliminary specifications were written for two continuous pusher type furnaces, each with a capacity of 25 tons per hour. With the slab lengths required for the mill, a double row of 78-in. slabs gave a hearth width of approximately 15 ft and to obtain 50 tons per hour capacity, the furnace length would be such that slabs

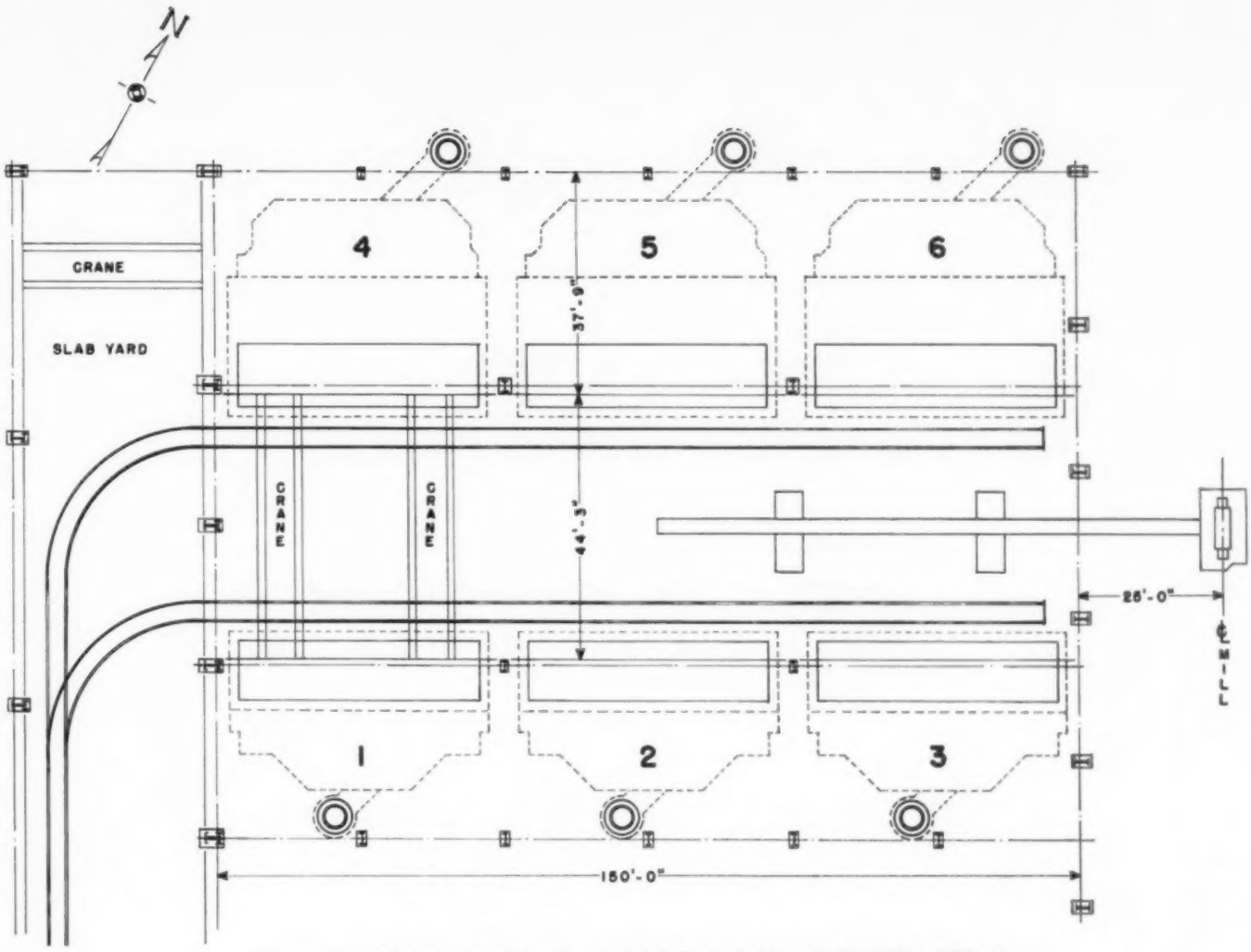


Figure 1 — Layout shows former heating installation at Alan Wood Plant.

which varied from 3 to 8 in. thick could not be pushed without buckling. By holding capacity to 25 tons with a short furnace, this problem should not be too serious.

Two other types of furnaces were considered, the tunnel type and the rotary hearth. The tunnel type apparently had a lot to recommend it, in that the slabs would be on piers on cars which passed through the furnace and would receive heat from all sides. The furnace also lent itself quite well to our material handling program. The greatest drawback would be high maintenance and a loss of efficiency due to cooling of car brick work, with necessary reheating while car was out of furnace.

The other consideration was loss of heating for production during installation.

As a result of these factors the tunnel type furnace was discarded, before cost estimates were obtained.

Figure 2 shows the proposed location for installation of two continuous type pusher furnaces — and shows also what was proposed in the way of material handling equipment.

This layout shows the problems. In the location as shown, it meant relocation of another department which was in the space required for entry tables and pushers. Most of the furnace could be built, however the discharge end would have to wait until the entire mill was shut down, as the runway for charging machines was too low and would not clear the furnace. To move to the north side, there would still be the same problems with charging machines, and it would be necessary to lengthen slab yard runway to reach entry tables and depiler.

Figure 3 shows only the preliminary location for tunnel type furnace and what would be required for material handling.

The equipment for handling cars, transferring slabs, etc., would appear in this case to be of considerably more extent than for either pusher or rotary hearth type furnace, with many more chances for failure. It is also a little hard to visualize how even a four-man crew are going to be able to handle 75 pieces per hour.

The manpower requirements for each of these two schemes as well as for the rotary hearth furnace which was installed are discussed later.

Returning to the continuous pusher type furnace, there was the following specifications for slabs which had to be handled.

Width	18 to 30 in.
Length	22 to 78 in.
Thickness	3 to 8 in.
Weight	500 to 5000 lb

As may be seen, a double row of the longest slabs would require a hearth width of 15 ft, and four skids would be sufficient, however as the operator keeps shortening to a slab length of 22 in., there is an abnormally high number of skids with a very difficult job to

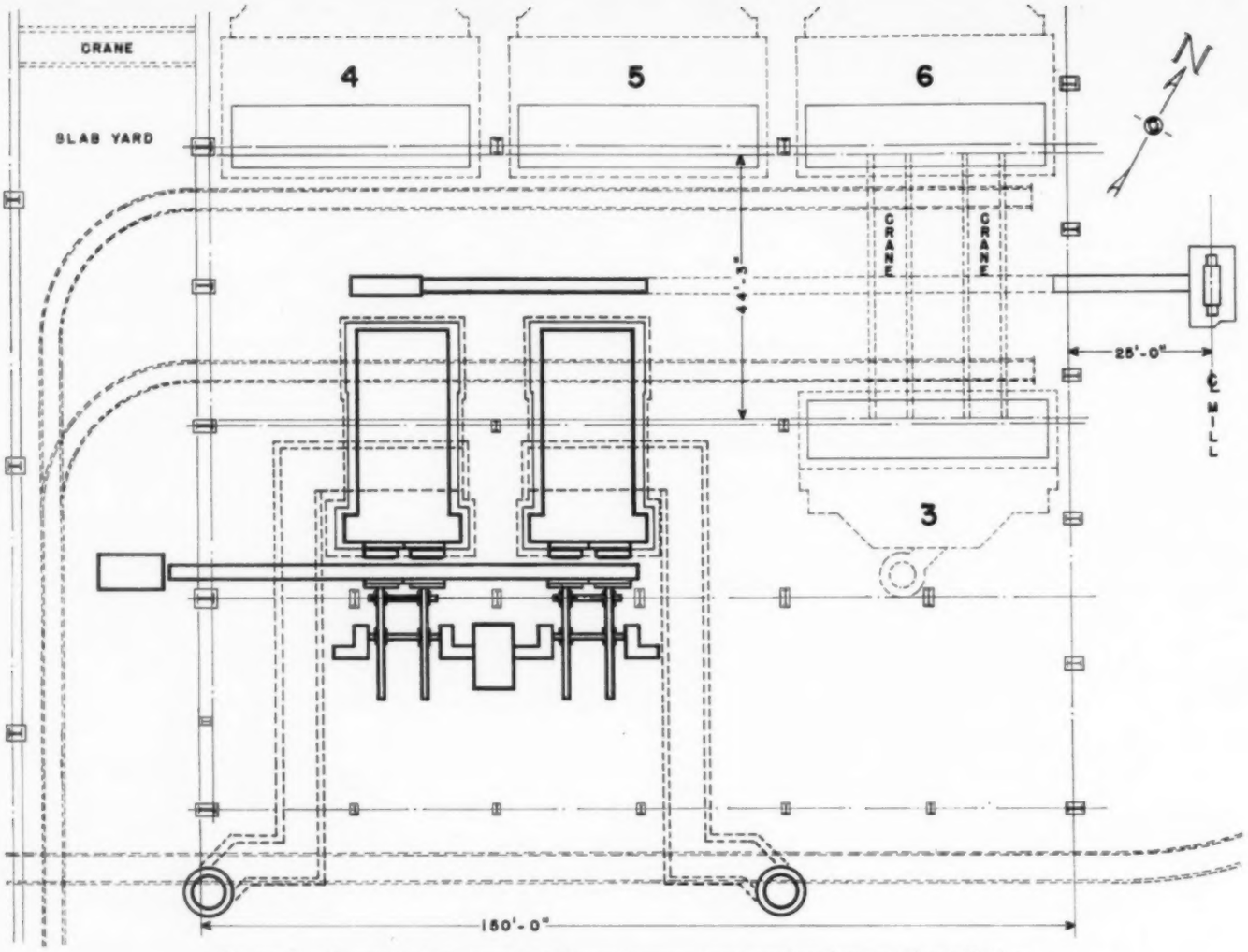


Figure 2 — Layout shows proposed continuous type pusher furnace installation.

keep them covered. The matter of support over lower furnace chamber, in a 3-zone furnace created still more problems.

The study was continued, however, to give the complete story of installed cost, which included necessary material handling equipment and labor force.

The forseeable difficulties of handling the slab sizes in a continuous pusher type furnace made the advantages of the rotary hearth furnace much more obvious. The rotary furnace had, however, one major disadvantage for our application. Many rotary furnaces heat steel to rolling temperatures, but no one knew of one

TABLE I

Comparison of Continuous Furnaces

Rotary furnace	2-Zone continuous pusher	Tunnel
Easily handle wide range of slab widths, lengths and thickness.	Difficult skid and pusher arrangement for slab lengths 22 to 78 in. Difficult to push 3 to 8 in. thickness range.	Easily handle wide range of slab widths, lengths and thickness.
Unproven for heating slabs.	Conventional and proven type for heating slabs.	Unproven for slab heating, but no difficulty expected.
25 per cent production loss for installation.	33 per cent production loss for installation.	50 per cent production loss for installation.
100 per cent production loss with furnace delays.	50 per cent production loss with furnace delays.	100 per cent production loss with furnace delays.
3-man crew.	4-man crew.	4-man crew.
Low scale loss.		Low scale loss.
Low cooling water requirements.	High cooling water requirements.	
Lowest initial cost.	High initial cost.	
		Anticipated high maintenance cost.

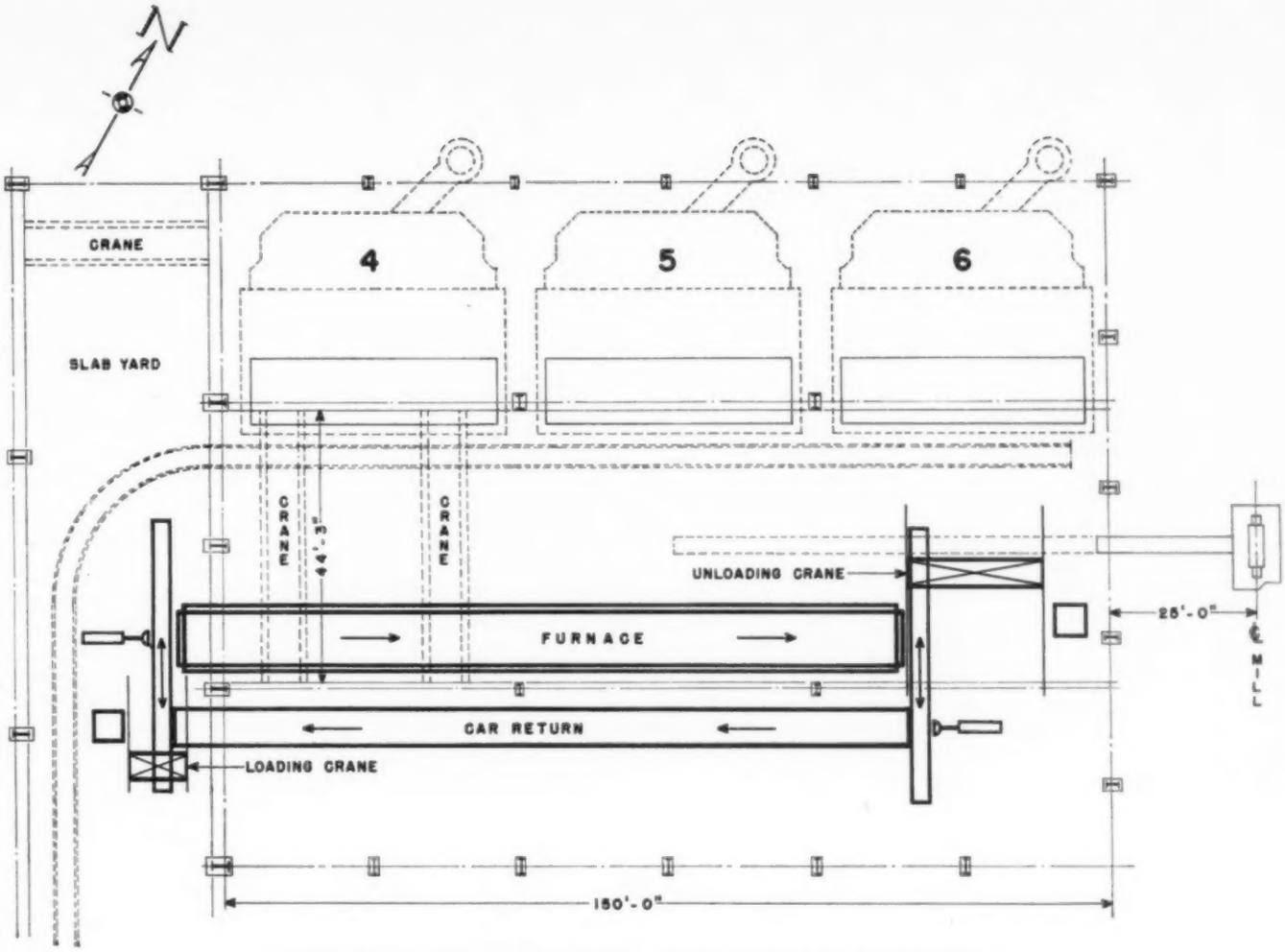


Figure 3 — Layout shows proposed tunnel type furnace installation.

which heated slabs, rounds and billets, yes, even in sizes much heavier than proposed, but heat could get at the steel from three sides, where it was believed that heating from the sides would be negligible with slabs.

Accordingly through arrangements made by a furnace builder, a Beaver Falls plant permitted tests on heating some slabs in a 55-ft diameter furnace they used for heating billets over 11-in. square.

Slabs 8 × 25 × 60 in. were prepared by drilling and attaching thermocouple leads of such a length that a record of the entire heating cycle could be obtained. However the experiment was not a complete success, loss of leads occurred after slabs had traveled approximately 150 degrees. In addition, the readings prior to couple loss started varying widely as checked with an optical pyrometer. The slabs were checked as they passed the various furnace doors, by means of an optical pyrometer and heating appeared to be very uniform. Neglecting the couple failure, the test was a success in another way, after slabs were discharged, optical readings indicated a good temperature — uniform top and bottom, indicating that possibly there was nothing to fear if all heat went into top of slab only. If one applied here the thinking of how heat gets into slabs in a two-zone continuous pusher furnace, one would expect to find this condition.

After the test had been completed and thoroughly discussed, it was felt that a complete estimate of installed cost including material handling, labor costs, loss of production during installation etc., should be made.

Table I gives a brief outline of the various items considered for the three types of furnaces.

Returning now to several points mentioned in the preceeding comparison, for further clarification, it was estimated the installed cost for two 25-ton pusher furnaces with stacks, necessary building changes, equipment relocation, charging and discharging tables, pushers, etc., necessary to bring slabs from slab yard, heat and deliver to the mill table to be $1,400,000, as compared to $925,000 for a rotary furnace under the same conditions.

Labor force distribution estimated is given by Table II.

TABLE II

	Rotary furnace	Pusher furnace	Tunnel furnace
Heater	1	1	1
Entry table operator (depiler)	1	1	1
Charger operator	1	1 or 2	1
Discharge operator	0	0	1
	3	3 or 4	4

Weighing all of the above advantages and disadvantages as well as attempting to evaluate some of the questionable items, all concerned agreed that the rotary

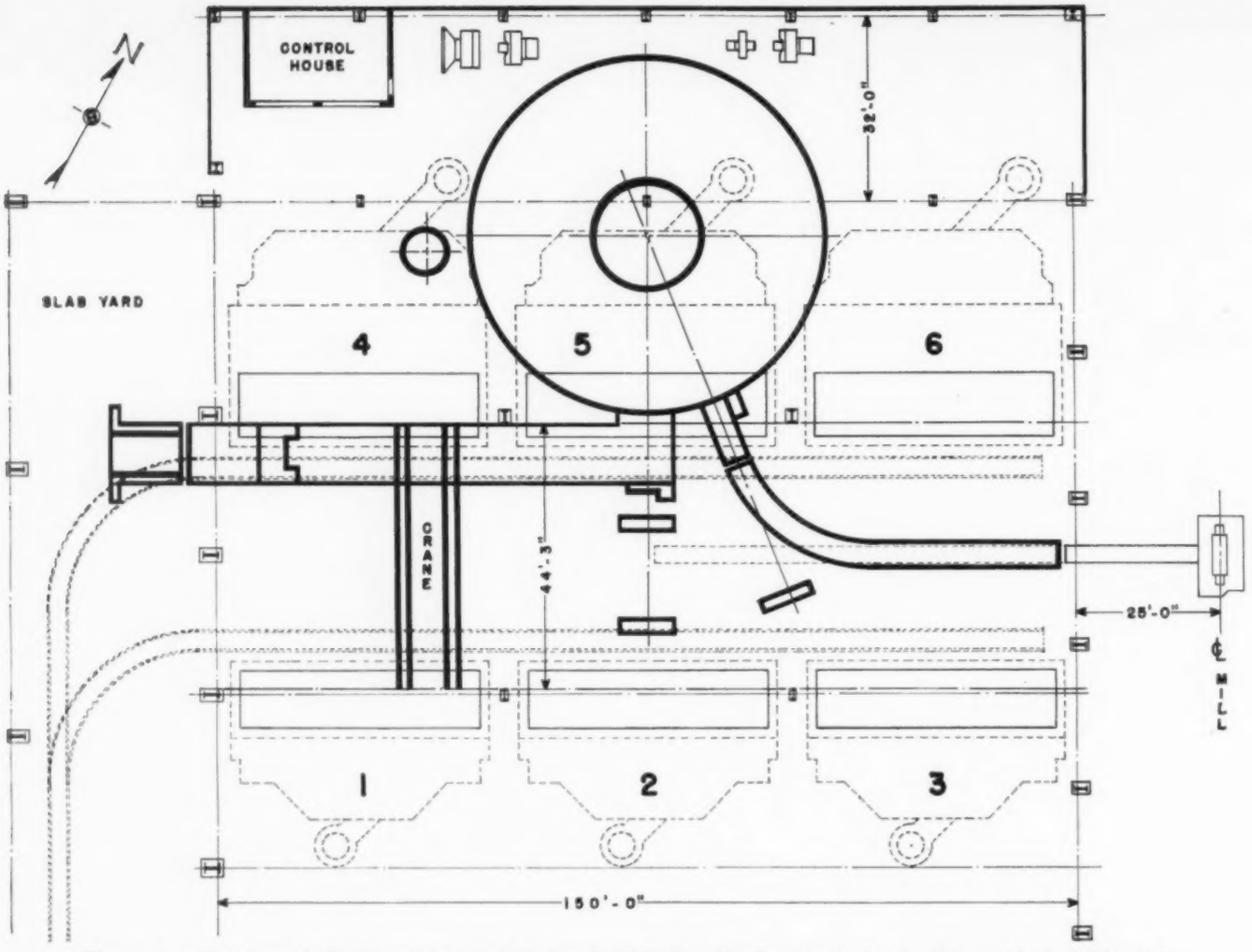


Figure 4 — The layout shows rotary type furnace installation finally adopted, superimposed on old layout.

hearth furnace best met the particular requirements. The layout shown in Figure 4 was adopted and installed.

Briefly this installation is as follows:

Stacking bed.
Depiling crane.
5-Strand conveyor.
Charger.
Furnace.
Discharger.
Curved and straight table to mill.

Slabs are deposited in piles by a tong type crane in the slab yard on a stacking bed which has a fixed bumper for end of pile position. A depiling crane having only bridge and hoist motions with double magnet then deposits slabs on a 10-fpm, 5-strand conveyor. Due to the bumper already mentioned, the furnace end of slab is in the proper location for fixed jaw of furnace charger. At the furnace end of conveyor there is a power operated movable bumper with position indicator and conveyor limit stop switch. The movable bumper allows operator to stop slabs of varying width in a central position under jaws of charging ram.

The furnace end of ram has a fixed jaw, clamping being done with hydraulically operated moving jaw on carriage end. Slab is raised from conveyor, and then charged into the furnace either in single row or double row, dependent on slab length. The settings are controlled by the operator and can be changed as required very quickly. Discharge unit is a duplicate of the charging machine.

The furnace has an outside hearth diameter of 55 ft with a hearth width of 15 ft, giving an area of 1885 sq ft. The hearth indexes to give any desired setting from 33 to 84 rows. Charging, hearth movement and discharging can be controlled manually or automatically as desired. Maximum charge and discharge rate is 75 pieces per hour.

The furnace proper is arranged in five zones with burners applied in zones No. 2 to 5 inclusive. Heated gas moves counterflow to hearth rotation, being discharged to stack from a point near charging door in zone 1.

Burners are combination oil or gas, fuels being Bunker C fuel oil and coke oven gas. Maximum fuel input is approximately 130,000,000 Btu per hour.

Charging door is on a radial line at right angles to cold slab conveyor with discharge door spaced 22½ degrees away.

The furnace is a conventional rotary hearth furnace with zone No. 1 being a preheat zone taking advantage of the hot gas before going to the stack. Zone 5 is a very short soaking zone, perhaps more effective in counteracting any cooling due to discharge door opening than actual soaking or heating. One unusual feature was the provision 54 degrees from charging door in zone No. 4

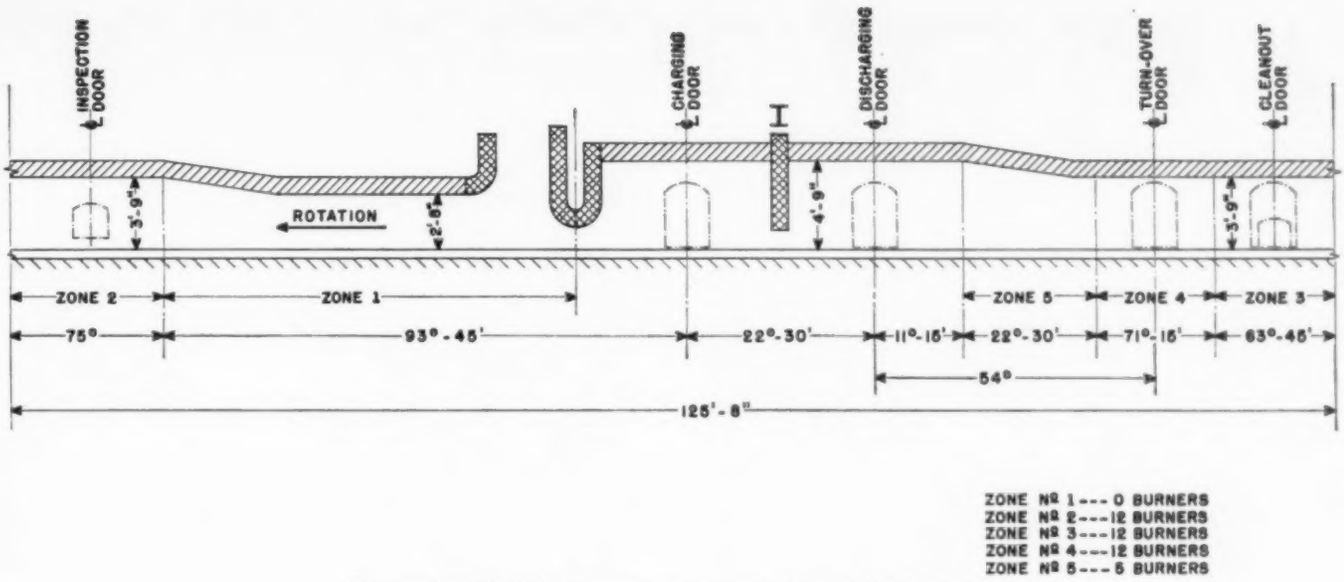


Figure 5 — Sketch shows an unwound view of the furnace.

of another large door. Even after the decision to install a rotary furnace, some doubt remained, whether heating could be accomplished from the top of slab only. This third door was provided so that, if necessary, equipment could be installed for turning slabs over. Fortunately to date, the only use has been to provide a replacement when discharge door was broken.

The furnace is fired by 41 combination coke gas and steam atomized Bunker C fuel oil burners. Zone control of temperature is motivated by closed tube radiation units located in the side walls. Separate combustion air fans are used on each zone with air flow for fuel ratio adjustment being controlled by hydraulically operated butterfly valves. Fuel and air flow for each zone is metered and in addition a master meter is used for total fuel. Furnace pressure impulse is obtained through the roof near charging door, and control is by means of a vertical stem water cooled butterfly valve with hydraulic operator located in the overhead waste gas flue. Power for operation of damper and fuel air ratio controllers is supplied by a dual pump arrangement. The temperature control instruments regulate standard electric driven valves in the fuel lines of each zone.

REFRACTORIES

The furnace hearth consists of a 6-in. top course of super duty brick, 3 in. of castable refractory, 4½ in. of insulating refractory, and 6 in. of insulating concrete. The steel work of the hearth bottom is only hand warm.

The furnace side walls are constructed of 13½ in. of insulating fire brick backed up with 1¼ in. of block insulation. In the heating zones, 2800-F type brick are used, and 2600-F type are used in the preheat zone. The 9-in. thick roof is the flat suspended type, with 2800 F insulating firebrick suspended on refractory hangers which are held by castings and vertical rods attached to light steel members placed radially around the furnace. To date these insulating refractories have remained in excellent condition, with virtually no spalling or fusion being evident, in spite of the fact that temperatures exceeding 2450 F sometimes have been used.

The inside wall is anchored to the steel shell by means of alloy brackets in order to prevent any tendency of the wall to increase in circumference as it is heated up and thus pull away from the steel shell.

The hearth of the furnace extends under the side walls. The base of the wall, which overhangs the hearth, consists of two vertical courses of superduty quality brick, each of which is held on castings in such a manner that the bottom courses can be removed and replaced from the outside, while the furnace remains in operation.

The hearth carries a water seal trough equipped with plows and drop pockets into which any debris from the hearth falls and can be easily removed. Water level in each trough is maintained automatically, each trough having two sets of high and low level probes which are connected to solenoid operated valves.

The counterflow of gases against rotation was mentioned. This is helped with curtain walls between charging and discharging doors. Figure 5 gives an unwound view of the hearth, roof line, charge and discharge doors, baffles and stack take off, and also serves to point up the length of furnace obtainable for heating in a small space.

This has been a rather brief description of the furnace

Figure 6 — View of furnace, looking toward charging machine, shows left to right, stack, waste gas flue, entry conveyor, hydraulic pump.

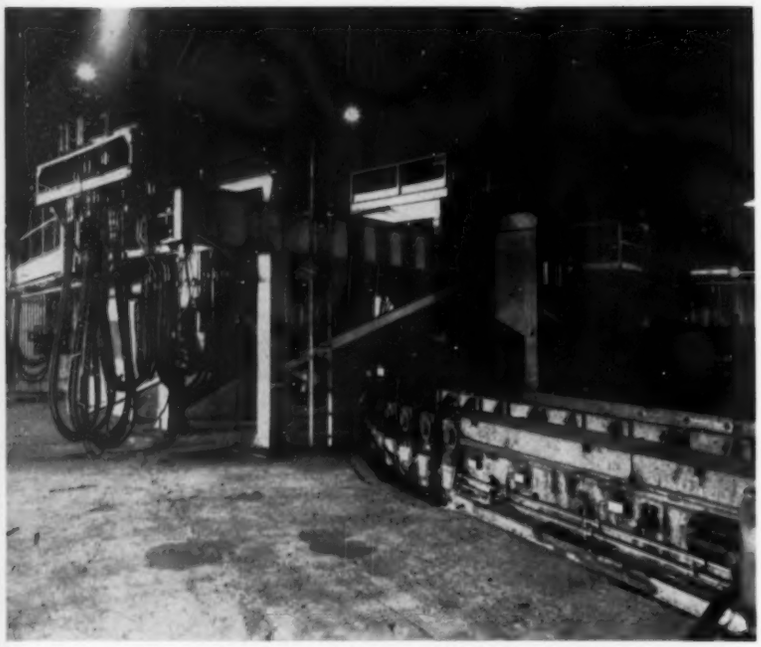


Figure 7 — Delivery side of furnace shows discharge table (curved and straight) leading to mill.

but as previously mentioned, the rotary hearth furnace is not a newcomer to the iron and steel industry and the literature is full of detailed furnace descriptions.

Figure 6 is a view of the furnace looking toward charging machine, and shows the entry conveyor, hydraulic pumps and waste gas flue.

Figure 7 shows the delivery side with curved and straight tables leading to the mill.

Figure 8 is a view of control house which is pressurized.

The erection schedule of the furnace and auxiliary equipment might be of interest. The middle furnace on the north side of the shop was shut down March 13, and torn out with foundation work starting four days later. Foundation work for the furnace proper was completed and furnace erection started May 15. On July 1, furnace No. 4, on north and west end of shop was shut down to permit installation of stack foundation, stack and entry conveyor. On August 7, the mills were shut down and construction of foundations for furnace discharge table, piers for charge and discharge mechanism, and erection of this equipment started. On the 1st of September, the first slab was discharged from the furnace essentially completing the installation.

Figure 8 — Furnace control house is pressurized.

With this time schedule normal work weeks with very little overtime were worked, until just prior to the mill shutdown. Until the second batch type furnace was torn out rail service was maintained on both sides of shop. At the time of mill shutdown, the furnace was nearly complete, the remaining work consisting of erection of charge and discharge mechanisms, some fuel piping and completion of wiring to operators benchboard.

Since putting this equipment into operation at Alan Wood in September 1954, many things have been learned which will be mentioned in the hope that they may help others avoid some of the problems.

As stated previously, heating for the plate mill had been with batch type furnaces, and to establish desirable heating and pieces per hour rates, many records were examined, both as to tons per hour rolled, tons per turn and per year. On the basis of these figures, a rate of 40 tons per hour or 75 pieces per hour were established. Using a heating rate of 20 to 25 minutes per inch of thickness sized the furnace. One very important item was not discussed as thoroughly as it might have been, and that is the effect of the thickness variation on tons per hour. With the batch type furnaces, thin slabs were heated quickly, while thicker slabs required long heating time. When combining this combination in a continuous furnace, it reduces piece per hour output as thickness is increased due to the constant heating time per inch. In other words, thin slab output is reduced as soon as thick slabs are charged. This may reduce tonnage output for the short interval until the thick sections are ready to be discharged. It was found that the details of scheduling to take advantage of start up, roll changes, etc., and thus gain on total heating time were much greater than any one realized or anticipated. The other difficulty, although recognized in the planning, has been to get full hearth coverage. This of course is due to the great variations in slab lengths. It is recommended that when trying to transfer heating results based on batch type furnaces to a continuous furnace, that continuous furnace capacities be increased by one-third.

The hydraulic pumps, one each for the charger and discharger with a spare were originally mounted on top of the two units, directly over the furnace operator. This created a bad condition with oil leakage, etc., but since original installation could be made faster with this location it had been accepted. However, after all of the batch type furnaces were removed and floor paved, the pumps were relocated to ground level. Such an original location is recommended if space is available, as it permits better maintenance and inspection.

As might be anticipated after looking at all of the possible patterns of charging this furnace, there are a very great number of electrical relays, contactors, limit switches, etc. During the latter stages of erection and continuing into first weeks of operation, crews were trying to paint and repair the building. The dirt knocked down, even with drop cloths protecting the equipment gave experience in servicing electrical control which otherwise might have taken months to obtain. As a result of electrical failure, the charge and discharge rams were stuck in the furnace several times. Consequently a separate source of power was provided, through a double-throw switch, to the trolley motor

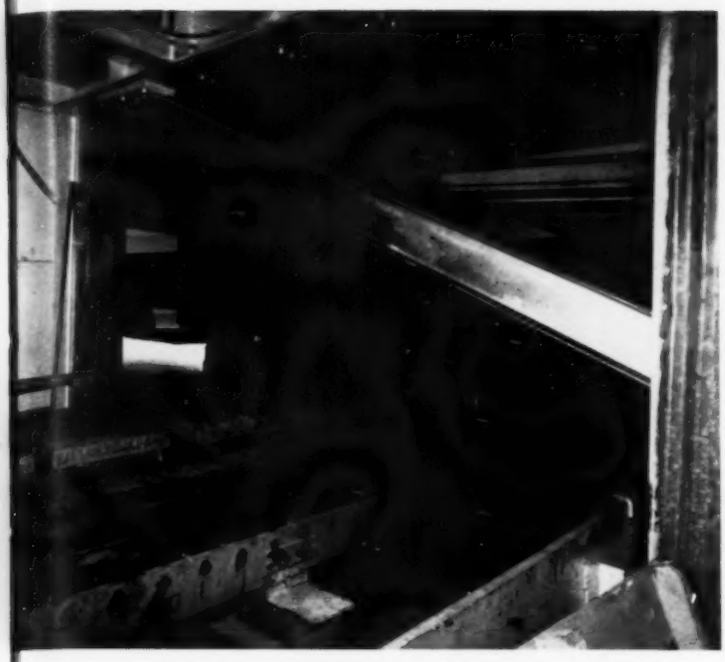
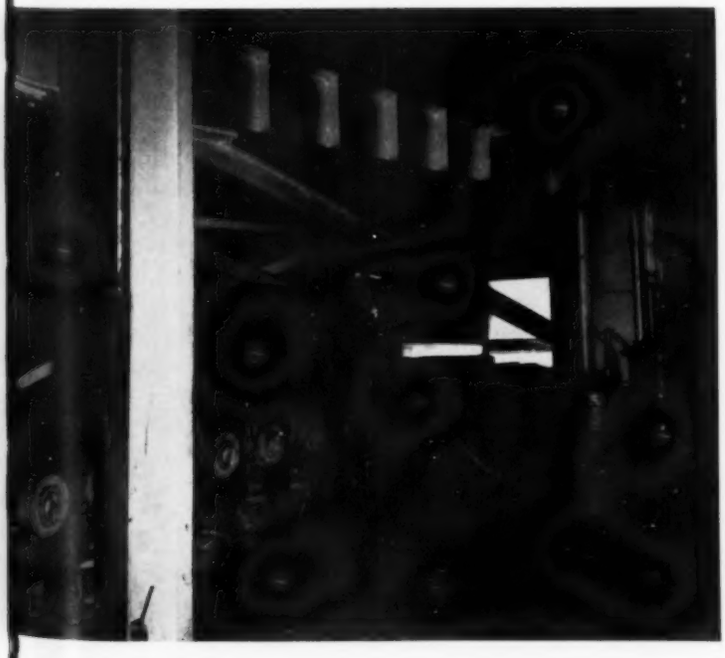


Figure 9 — Slab is being charged to furnace.

which permits getting ram out of furnace quickly, and it has paid for itself.

Another item, learned the hard way, is the weakness of suspended curtain walls. After some failures, it was found that other users experienced the same difficulty, but it was still discouraging to lose a wall once a week. About one month after the furnace went into operation, a simple water-cooled support consisting of a piece of 6-in. schedule 80 pipe with a channel on top to support a curtain wall of insulating firebrick was installed. Cooling water was carried to far end of the 6-in. pipe through a centrally located 2-in. pipe, with return flow surrounding it. The 6-in. pipe was studded and insulated. To date this wall is still in place and looks as good as when it was installed.

Figure 10 — Slab discharge conveyor and ram are discharging slab to conveyor.



The furnace was only one part of a complete rearrangement and modernizing of Alan Wood's plate mill and consequently there was a period of training required for personnel throughout practically every operation. For this reason, the final picture is just emerging and it appears as though the rotary hearth furnace is meeting expectations. Perhaps with the experience gained, if job were to be done over a larger diameter furnace might be installed. A larger furnace would reduce some of the scheduling problems, but this would likely be with some loss of fuel economy. Notice here, it was said that a larger furnace *might* be installed, not a different type, which is another way of saying that the rotary hearth furnace for heating plate mill slabs has been found worthwhile.

DISCUSSION

PRESENTED BY

W. T. BOSWORTH, Assistant Vice President—Sales, Salem-Brosius, Inc., Pittsburgh, Pa.

CHARLES H. SCHWERIN, Manager, Furnace Division, The Gas Machinery Co., Cleveland, Ohio

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

J. L. MILLER (deceased), Former Assistant Chief Combustion Engineer, Republic Steel Corp., Cleveland, Ohio

W. T. Bosworth: Mr. Schoen, although staying for the most part with generalities, has effectively justified the selection of the rotary hearth type of furnace for slab heating applications.

As pointed out, the use of rotary hearth furnaces for metal heating is not new, and in recent years, the advantages of this type of furnace for heating material of substantial cross-sectional dimensions has been recognized. Alan Wood recognized these advantages in specifying the rotary type furnace for heating slabs from 3 to 8 in. thick and 18 to 30 in. wide.

The advantages of uniformity of heating, fuel economy, flexibility of operation, and such were probably first realized in the steel industry by the tube mills and virtually all modern tube mills use rotary hearth furnaces for billet heating.

In addition, however, there is a definite trend in this country, as well as in Europe, toward using the rotary type furnace for heating ingots or billets for making wheels, tires, rings, etc., and for heating blooms prior to rolling.

Standard Steel Works Division at Burham, Pa., has a 75-ft diam rotary for heating wheel blanks at 22 in. diam × 20 in. high, with productive capacity rated at about 31 tons per hour.

Armco Steel Corp., at Butler, Pa., has a 60-ft diam rotary for heating billets up to 20 in. diam × 27 in. long for heating billets for wheel forming. Capacity of this furnace is 33 tons per hour.

Bethlehem Steel Co. has a 55-ft diam rotary for heating wheel blanks 17 in. diam × 36 in. long at a rate of 33 tons per hour.

Babcock & Wilcox Tube Co., Beaver Falls, has a

55-ft diam rotary for heating 11 × 11 × 144-in. blooms weighing 5000 lb each at a rate of 35 tons per hour.

Taylor Bros. & Co., in England, uses a 70-ft diam rotary for heating wheel blanks. This furnace is rated at 40 tons per hour, and heats octagonal shaped billets up to 18 in. across the flats.

At Dalmine, Italy, there are several large rotary type heating furnaces, one of the most interesting of which is a 55-ft diam unit heating 11,000-lb ingots, 30 in. diam.

The layout of the Alan Wood furnace and conveyors as shown on Figure 4 is a truly continuous operation from the slab yard to the mill. This has been obtained with an efficient use of floor space. The blowers and control house are located on the blind side of the furnace. The hole of the doughnut or center of the furnace has been utilized for hearth drive and the combustion control and conditioning equipment. All conduit and impulse lines are run from the furnace to the control house through an underground tunnel. It is interesting to note that in an emergency, the equipment could be continuously operated in reverse.

As pointed out by Mr. Schoen, there are problems to be encountered in applying continuous heating to a plate mill when the thickness of slabs vary from 3 to 8 in. This is particularly true when the thickness of slab to be run through the furnace changes many times a day.

The charger and unloader are separate, self-contained units, each complete with its own drive and switch gear. The two machines are mechanically identical, the only difference being the order of movements, which enables the charger to pick up cold slabs and place them in the furnace while the unloader picks up hot slabs, removes them from the furnace and places them on the mill conveyor. The two machines can be operated on different cycles. The furnace hearth can be loaded on one set of hearth stations and unloaded on a different number of hearth stations. This permits efficient hearth loading for various slab sizes.

The slab thickness determines the heating time. Obviously, when the various slab thicknesses are being heated simultaneously, the heating time for the thickest slab will set the pace with a resultant loss of tonnage on the thin slab. This is somewhat a scheduling problem, but is dictated by economic conditions; and is one problem that is constantly before the operator. Skill in scheduling will make a vast difference in furnace efficiency and productivity.

Mr. Schoen outlined a comparison between several types of continuous furnaces when they were analyzing the mill modernization program. I wonder if the production picture has crystalized to the point where production figures can be quoted. I am referring primarily to fuel economy, slab uniformity and manpower.

Charles H. Schwerin: I am going to limit my discussion just to two brief points, first, for some time I have been advocating the application of rotary hearth furnaces to many steel mill problems, but the engineering groups have tended to bypass the rotary hearth in initial planning because of major changes to mill layouts. Mr. Schoen's paper brought out how easily a rotary furnace fitted into a present mill application. In fact, in this particular case, Mr. Schoen has pretty well proven that the rotary hearth furnace is the most advantageous layout.

Second, it is also interesting to keep in mind that of all the rotary hearth furnace applications in the United States today, about sixty per cent of them are operating in mills that had been revised from original layouts. We have had only about forty per cent in brand new mills designed around the rotary hearth furnace.

The other point that Mr. Schoen brought out is that if he had the problem to do over again, the only thing that he would change would be the size of the rotary, not change the mode of heating, which is quite complimentary.

I might mention that with a rotary hearth furnace applied to heating of slabs ranging from 3 to 8 in. in size, you get into a problem, especially in the thicker slabs, of trying to get a lot of heat into the slab through the surface in the initial stages of your furnace, thus defeating to a certain extent the design of preheating.

Now, you could probably go to a larger rotary hearth furnace, taking advantage of a greater economy for the thicker slabs in an over-all operation, or you might also accomplish the same production in a smaller furnace by giving up a little efficiency and raising the temperature in the preheat zone to put a lot of heat in the thicker slab at that stage of the heating.

F. C. Schoen: In answering Mr. Bosworth's question on production records, I have been following the furnace rather closely for some time. We are running about 2,500,000 Btu per ton, and it is pretty consistent at this point. We do not feel it is too bad, considering that we are not getting the maximum hearth coverage that you might get if we had a more uniform product mix.

J. L. Miller: What is your hearth coverage?

F. C. Schoen: I believe we get up around 60 per cent of usable hearth. We have just about reached the top. It does not seem that our orders run long enough in any one group to do any better than that. You are running along on a certain size slab and you stick a couple of small ones in which breaks your pattern.

J. L. Miller: Is not your average coverage more nearly say 35 per cent of the total hearth?

F. C. Schoen: The operators seem to think it is thirty-five per cent. Actually, on that 40 ton per hour furnace, I have seen eight-hour turns with an average of 42, 43 tons per hour coming out of the furnace. Equally, I have seen on eight-hour turns an average of about 15 tons coming out of the furnace. It is all in the way the product mix varies.

One thing that George Schwerin brought up was about putting additional preheat in the heavier slabs. We have tried to handle this a little bit differently. When we get a couple of the heavier slabs in the center of an order, we put them in and let them go around twice and that works out pretty nice. We have gone to the practice also on certain production items which are regularly eight-inch thick of which we are only producing maybe four or five plates in a twenty-four hour period in which they are allowed to come around twice and be picked out, and a little later, we slide two more in.

That seems to have eased the heating problem and helped hold the furnace up on tonnage for the mill, but most of the time, I believe we can really say that the furnace is waiting on the mill to take the steel away, especially on 4 in. and thinner sections.

Reel Control Systems for Mills and Process Lines

By A. J. WINCHESTER, JR.
Industry Engineering Dept.
Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . to obtain good coils and minimize spoilage, it is essential that constant tension be kept on the strip during coil buildup . . . . this requires a good reel control system with a scheme suitable for the application plus the right components . . . . magnetic amplifiers have shown that they will give the precision performance and reliability necessary for reel control systems . . . .

▲ SINCE practically all modern mills for hot and cold rolling of metal strip have one or more reels, a knowledge of reel control systems is important. To increase efficiency and reduce operating costs, the industry continually demands higher strip speeds and larger coils. Reel control systems have kept pace with this demand.

Constant tension throughout coil buildup is a basic requirement for most reel systems. Some mills handle coils up to 85 in. in diameter, which are wound on a 15-in. mandrel. A coil buildup of up to 3½ to 1 is normal, but 4 to 1, 5 to 1 and higher are occasionally used. Uneven tension during coil buildup results in a coil with irregular edges; such a coil is difficult to handle, the edges are easily damaged, and more space is consumed. On one particular mill where the strip tension was varying over a wide range because of faulty operation, the edge of the coil formed about a 45-degree cone instead of a plane perpendicular to the coil axis!

BASIC CONCEPTS

Constant horsepower input to a reel drive with constant strip speed gives constant tension regardless of coil diameter. To produce constant tension, the torque developed must vary in direct proportion with coil diameter. Horsepower is directly proportional to the product of torque and speed. To maintain constant strip speed, the reel mandrel speed must vary inversely as the coil diameter. Since the reel drive speed varies inversely with coil diameter, torque is directly proportional to coil diameter, and strip tension is constant.

A portion of the power input to the driving motor goes into electrical and mechanical losses. In most cases, these losses are sufficiently small that for all practical purposes they may be neglected. Where a wide range of tension such as 10 to 1 or larger is required, the effect of the losses must be carefully considered. Friction and windage losses vary with speed of the reel motor. With constant horsepower input to the reel motor at constant strip speed, tension is constant only if the losses are constant. For applications which require maintaining tension over a wide range, it is sometimes necessary to make special provisions to insure constant tension at all coil diameters and mill operating speeds.

ACCELERATION REQUIREMENTS

Proper application of a reel drive system requires a review of the acceleration and deceleration requirements. Energy is required to change the speed of the drive because of the mass of the reel mechanical system and the armature of the driving motor. The acceleration requirements for two drives are shown in Figure 1. For a 10-sec acceleration to 1000 fpm for a coil with three to one buildup, the motor requires almost 70 per cent current at minimum coil diameter, but only about 15 per cent current at maximum coil diameter with strip 30 in. wide. For a 10-sec acceleration to 3000 fpm for the same coil, the motor requires approximately 84 per cent current at minimum coil diameter and 75 per cent at maximum coil diameter. For the coil alone with constant total accelerating time, the accelerating current required varies as the square of the strip speed. Effect of the coil mass on the acceleration requirements of the drive is reduced by a stepdown gear ratio between the motor and the drive. With a stepdown ratio, the coil inertia referred to the motor shaft is equal to the coil inertia at the mandrel divided by the square of the gear ratio. The shape and general appearance of the curve for acceleration to 1000 fpm in Figure 1 is characteristic for drives with large stepdown gear ratios.

Sometimes it is possible to control acceleration char-

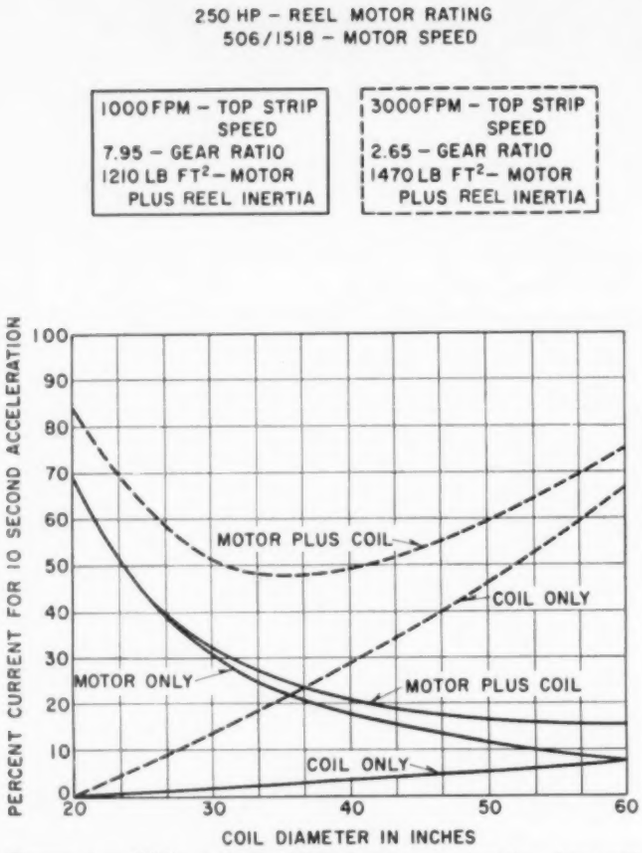

250 HP – REEL MOTOR RATING
506/1518 – MOTOR SPEED
1000 FPM – TOP STRIP SPEED
7.95 – GEAR RATIO
1210 LB FT² – MOTOR PLUS REEL INERTIA
3000 FPM – TOP STRIP SPEED
2.65 – GEAR RATIO
1470 LB FT² – MOTOR PLUS REEL INERTIA
PERCENT CURRENT FOR 10 SECOND ACCELERATION
MOTOR PLUS COIL
COIL ONLY
MOTOR ONLY
MOTOR PLUS COIL
COIL ONLY
COIL DIAMETER IN INCHES

Figure 1 — With a large step-down gear ratio, the coil usually does not have much effect on the acceleration load required. Motor load to accelerate the coil alone varies as the square of the speed changes.

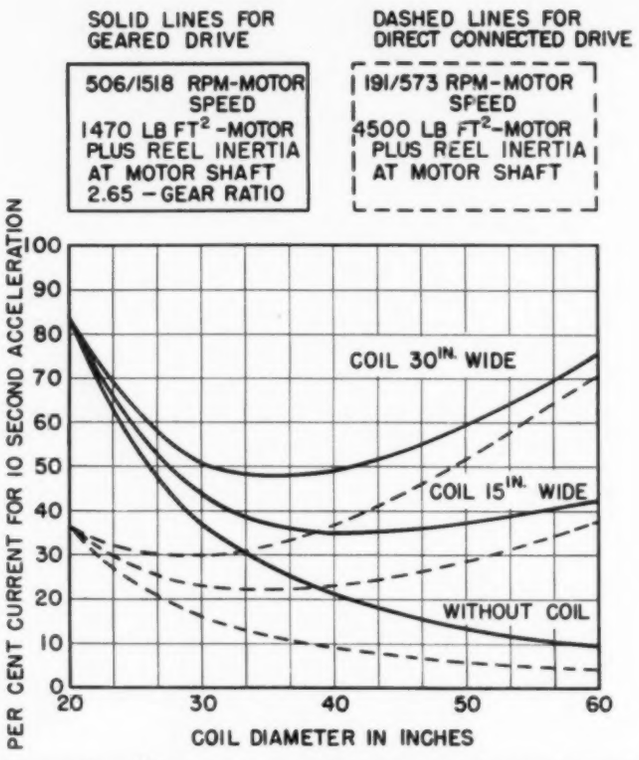

3000 FPM – TOP STRIP SPEED
250 HP – REEL MOTOR RATING
SOLID LINES FOR GEARED DRIVE
DASHED LINES FOR DIRECT CONNECTED DRIVE
506/1518 RPM-MOTOR SPEED
1470 LB FT² – MOTOR PLUS REEL INERTIA AT MOTOR SHAFT
2.65 – GEAR RATIO
191/573 RPM-MOTOR SPEED
4500 LB FT² – MOTOR PLUS REEL INERTIA AT MOTOR SHAFT
PER CENT CURRENT FOR 10 SECOND ACCELERATION
COIL 30 IN. WIDE
COIL 15 IN. WIDE
WITHOUT COIL
COIL DIAMETER IN INCHES

Figure 2 — When motor speed and gear ratio are changed, maximum difference in acceleration load occurs at minimum coil diameter. A change in gear ratio does not affect motor load required to accelerate the coil alone.

acteristics by selection of motor speed and gear ratio. An example of this is shown in Figure 2. A direct drive is compared with a drive with a 2.65 to 1 stepdown gear ratio. At full coil diameter, the acceleration requirements do not vary much, but there is a tremendous difference at minimum coil diameter. At empty reel, the acceleration requirements are determined exclusively by the inertia of the reel mechanical parts plus the motor inertia. Although the motor plus reel inertia is less, the motor for the geared drive requires a greater per cent current to accelerate in 10 seconds at minimum coil diameter because the motor must accelerate to a higher speed at which it has a lower rated torque. Since at full reel, the coil is by far the largest component of the inertia which must be accelerated, the acceleration requirements of the two drive arrangements do not vary much at this point. It is desirable to keep variation in acceleration requirements over the range of coil buildup to a minimum. Usually it is the minimum coil diameter point at which the greatest change in acceleration requirements can be made by selection of motor speed and gear ratio.

Use of a chart like that shown in Figure 3 facilitates calculations. By placing a straight edge at the corresponding points for coil diameter and length, the inertia may be determined directly. Information obtained from this chart is sufficiently accurate for most calculations.

MOTOR SPEED RANGE

It is desirable to have a reel motor speed range which exceeds the range of coil buildup. The motor speed range should be at least 15 per cent greater than the coil buildup. Because of increased motor saturation at the full field end of the speed range, it is desirable to have the greater percentage of the margin at the lower speed end. A simple and good way to divide the margin is to select the gear ratio so that the difference in rpm is equal at each end of the range. For example, with a 450/1575-rpm motor the margin is 56 rpm at the low speed end and 57 rpm at the high speed end for the geared drive shown in Figure 2. This is easily calculated as shown in the example given below by making "x" equal to the rpm margin which is the same for both ends of the speed range.

$$(450+x)3 = 1575 - x$$
$$x = 56.3$$

CONE TYPE PAY-OFF REELS

When a cone type pay-off reel like that shown in Figure 4 is used, two separate drag generator armatures are required, and these may be connected either in parallel or in series. Although each scheme has advantages and disadvantages, the parallel arrangement has increased in popularity and is now most frequently used. The shortcoming of cone type coil holders is that it is impossible to balance the load between the two drag generators when one cone slips as occasionally happens in spite of all precautions. When two armatures are connected to a common load, load balance is possible

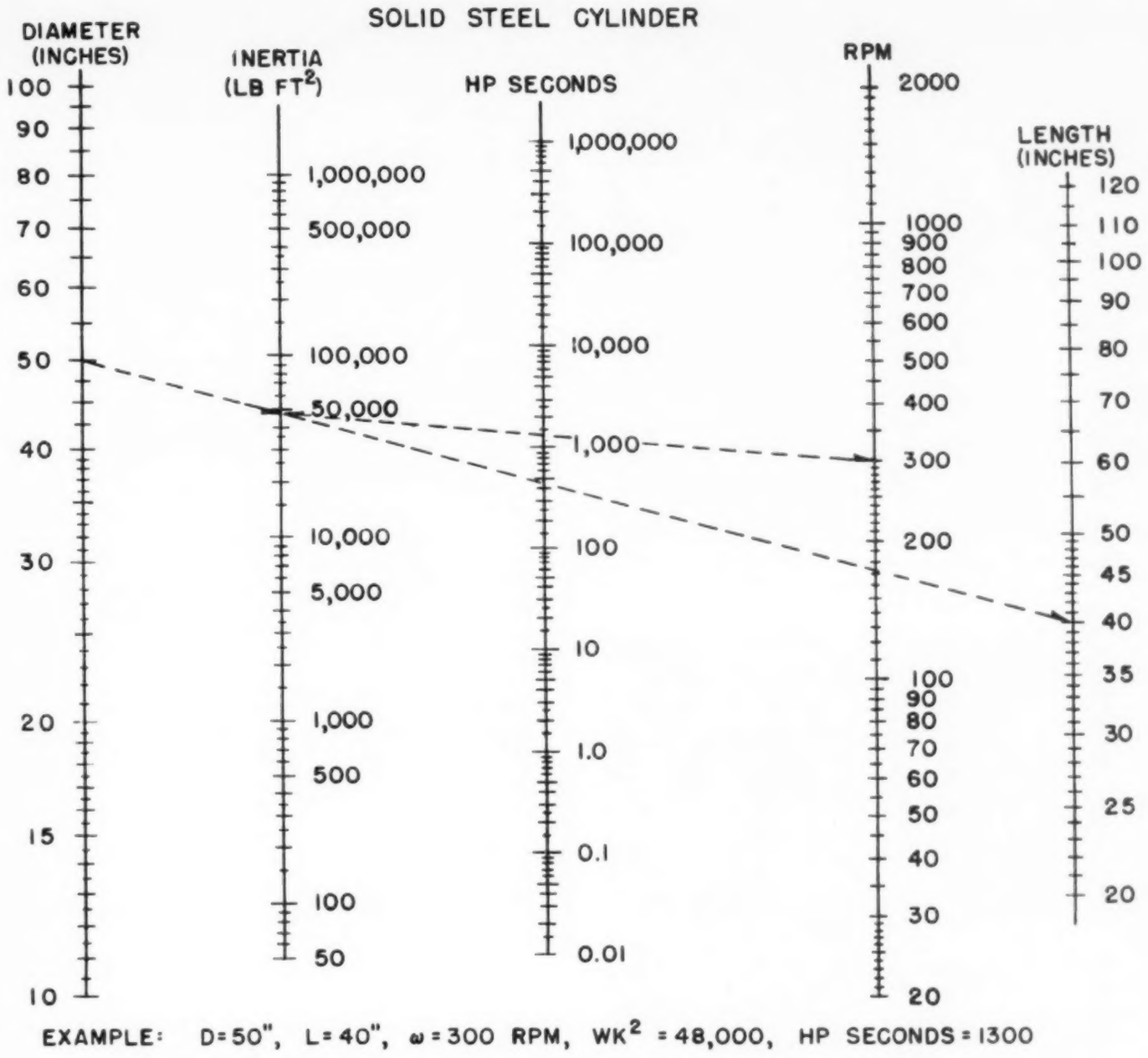


Figure 3 — Acceleration requirements for a coil may be quickly determined with this nomograph.

only as long as the mechanical connection exists between the load and both armatures. If with the parallel connection one cone slips, the armature which remains connected assumes, in addition to its own load, the load which was previously carried by the other armature. If one cone slips with two drag generator armatures connected in series, the armature which is connected to the cone which slips will decelerate; if this process is not checked, the armature which is free will decelerate through zero speed and accelerate as a motor in the opposite direction. Thus, although the series connection gives inherent load balance without requiring load balance equipment, it gives unsatisfactory performance if one cone slips.

SPEED REGULATIONS FOR PROCESS LINES

Some reel drives for process lines such as shown in Figure 5 require maintenance of strip speed proportional to a reference regardless of tension. This is usually the case on slitting lines and coil rewinding lines. A simple yet effective scheme for accomplishing this is shown in Figure 6. The motor armature is connected in series with a booster generator to an adjustable voltage bus. Reel motor speed is maintained proportional to the bus voltage regardless of strip tension or coil diameter. The reel motor field is connected in series with an adjustable resistor to a source of constant potential excitation; the resistor is adjusted so that the constant potential source supplies the minimum excitation which permits top speed of the reel motor at rated voltage. A unidirectional magnetic amplifier is connected across the motor field so that it can raise the motor excitation from minimum to full field strength. The control field of the magnetic amplifier is connected to the adjustable voltage bus in series with the armature of a pilot generator. The magnetic amplifier attempts to make the pilot generator voltage equal to and opposite in polarity to that of the adjustable voltage bus. Perhaps the easiest way to understand how the system functions is

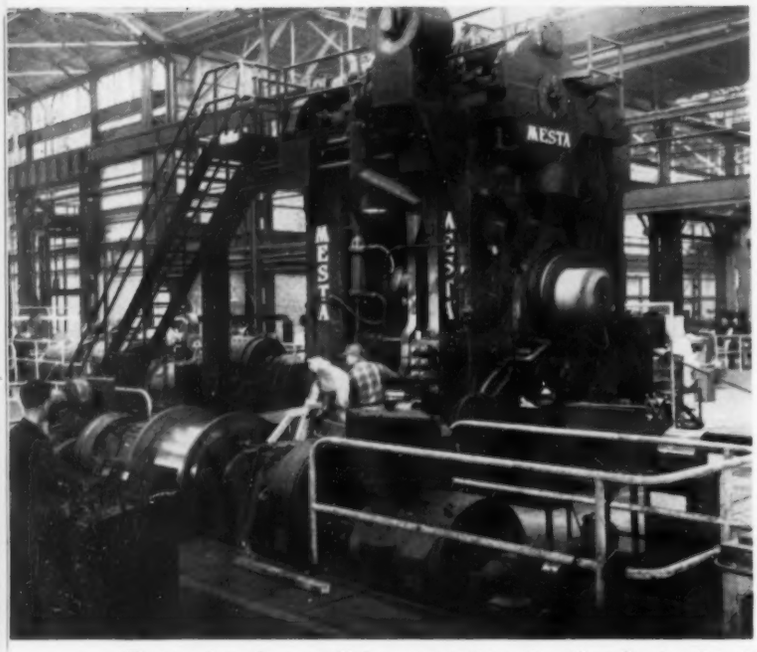


Figure 4 — A parallel connection is the best circuit arrangement for the two armatures of drag generators for cone type payoff reels.

Figure 5 — On a side trimming line, speed of the winding reel motor is regulated to maintain strip speed proportional to voltage of the adjustable voltage bus.

to describe what happens with a fixed voltage on the adjustable voltage bus as coil diameter increases on a winding reel. If reel motor speed is held constant, strip speed increases in direct proportion with coil diameter. Since the pilot generator is driven from a deflector roll or pinch roll which is in contact with the strip, voltage of the pilot generator is in direct proportion to strip speed. An increase in strip speed results in an increase in pilot generator armature voltage. When the pilot generator voltage exceeds the bus voltage, current flows in the magnetic amplifier control field in the direction to increase the strength of the reel motor field, which causes the reel motor to slow down. This process continues in infinitesimally small steps through-

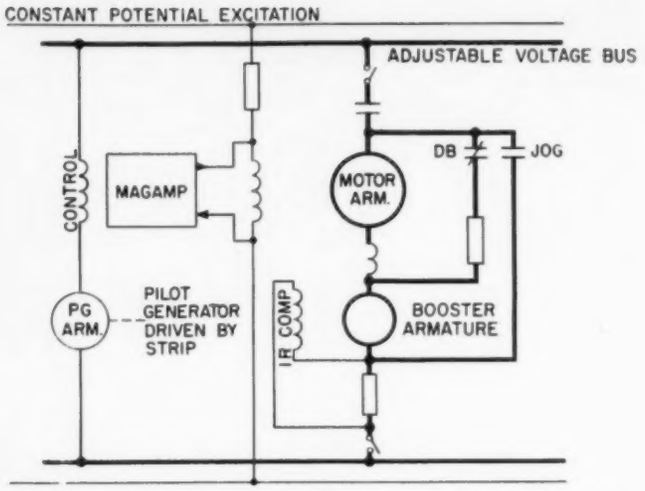


Figure 6 — A magnetic amplifier regulates speed of the reel motor so that strip speed is proportional to voltage of the adjustable voltage bus.

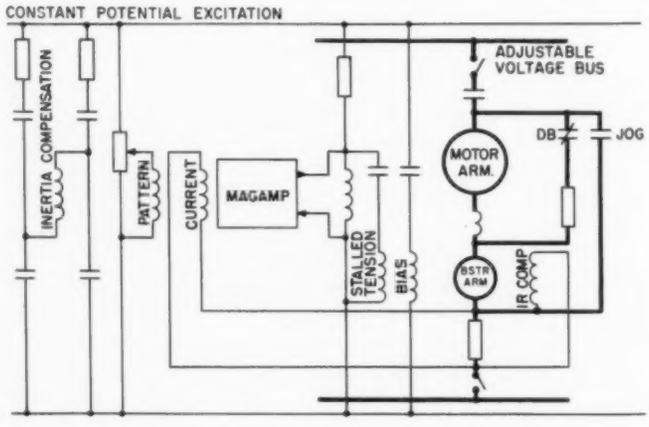
out coil buildup, so that reel motor field strength is continuously adjusted with coil diameter to maintain constant strip speed for a given bus voltage. The armature circuit booster generator provides IR drop compensation and is important when operation is required at low voltages.

Speed of the reel motor is limited in case of strip breakage by the minimum excitation supplied from the constant potential excitation source. The magnetic amplifier has unidirectional output, so that it can only increase reel motor field strength above the weak field value.

CONSTANT TENSION FOR PROCESS LINES

On many process lines, constant tension is maintained by regulating reel motor armature current. A typical and much used scheme for accomplishing this is shown in Figure 7. The reel motor armature is connected to an adjustable voltage bus. The reel motor field is connected in series with an adjustable resistor to a source of constant potential excitation, and the resistor is adjusted so that the constant potential source supplies the minimum field strength the same as for Figure 6. A magnetic amplifier with unidirectional output is

Figure 7 — Current regulation is used to obtain constant tension on many process line reels. A magnetic amplifier regulates current by controlling motor field strength.



connected across the motor field so that it can supply the additional current required to bring the motor from weak field to full field strength. The magnetic amplifier has three control fields: pattern, current, and inertia compensation. The pattern field acts in the direction to increase armature current by reducing motor field strength. The magnetic amplifier acts to keep strength of the pattern and current fields equal and opposite in direction. With constant strip speed, reel motor speed decreases as coil diameter increases. If reel motor field strength is held constant, armature current increases and motor counter-emf decreases as coil diameter increases. This increased current causes the strength of the current field to exceed that of the pattern field, which causes the magnetic amplifier to increase motor field strength. The motor field is continuously strengthened throughout coil buildup, so that the armature current is maintained at a constant value. The inertia compensation field has the effect of modifying the pattern field, so that tension is maintained constant during acceleration and deceleration. For a winding reel, the effect is to increase the strength of the pattern field during acceleration and decrease the strength of the pattern field during deceleration. The opposite is true for an unwinding or drag reel.

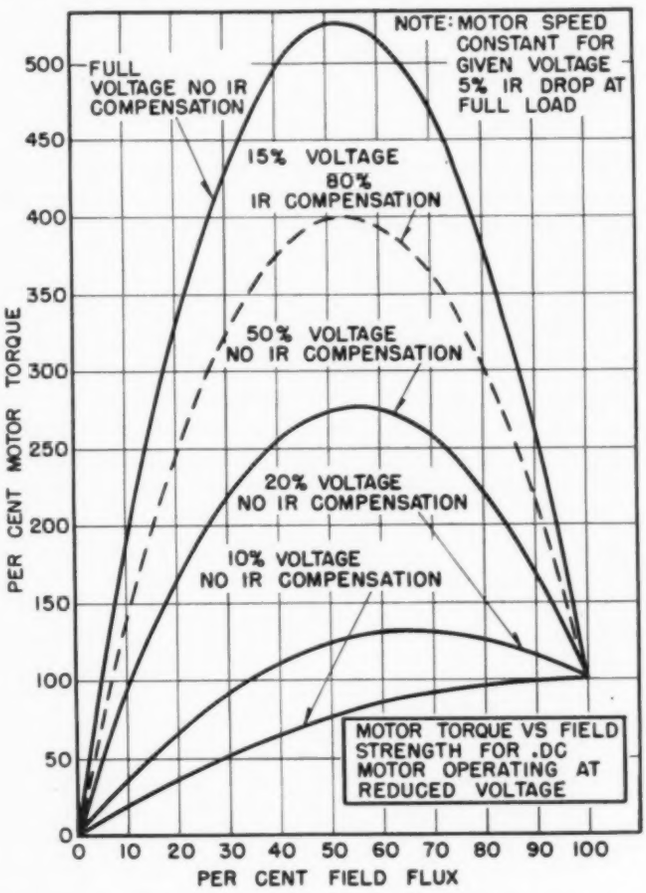


Figure 8 — At reduced voltage, peak torque obtained by reduction of motor field strength is limited.

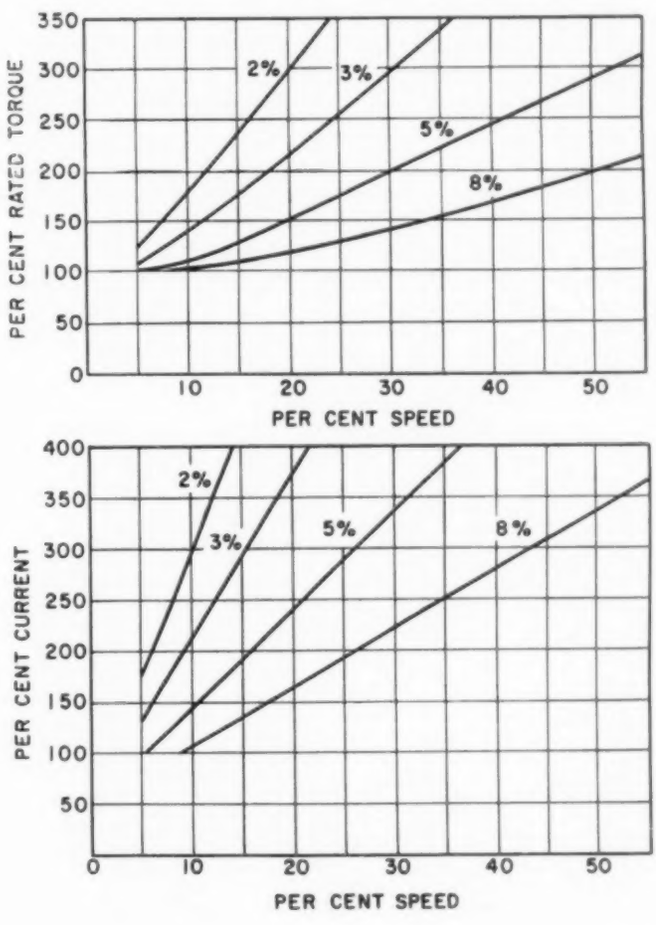
Maintenance of constant reel motor armature current with constant strip speed gives constant tension. For a given strip speed, the motor terminal voltage is constant. Since horsepower is proportional to the product of armature current and voltage, the horsepower input and tension are constant.

BOOSTER GENERATOR FUNCTIONS

Reel motor armature current is regulated when the mill is stopped by control of the booster generator voltage. This is necessary because motor armature current cannot be controlled by varying motor field current when the armature is not turning. On a winding reel, the normal action of the regulator is to reduce output to produce an increase in motor armature current. A differential field on the booster is connected to the magnetic amplifier output in parallel with the motor field, and a cumulative bias field is energized from the constant potential excitation source. Thus the booster stalled tension and bias fields act in opposition to each other. The magnetic amplifier produces reel motor armature current when the motor is stopped by making the net booster excitation cumulative.

A booster generator is required when it is necessary to have stalled tension or to operate at reduced voltage. Inertia compensation is obtained during acceleration by reducing motor field strength to obtain the necessary increase in torque. Since torque is directly proportional to the product of flux and current, at first observation

Figure 9 — Determination of when a booster generator is required is facilitated by these curves which give peak motor torque obtainable at reduced speed. For each ordinate the reduced speed is obtained by adjustable voltage with constant field flux, and the terminal voltage is equal to the counter emf plus the full load IR drop. The maximum torque and corresponding current are obtained by reducing field strength with speed held constant.



it appears that this is the wrong approach for obtaining increased torque; however, since at rated voltage a small reduction in flux causes a large increase in current, the net effect is to produce an increased torque. The peak torque obtainable is dependent on the voltage applied to the motor armature and the speed, and the peak torque is reduced as voltage is reduced. The variation under several conditions for a motor with 5 per cent armature circuit IR drop is shown in Figure 8. The peak torque which is obtainable at full voltage is over 500 per cent, but it is only 100 per cent at 10 per cent voltage. Addition of armature circuit IR drop compensation greatly increases the peak torque which is obtainable for a given condition, because it has the effect of reducing the armature circuit resistance. For example, a motor with 80 per cent IR drop compensation has an effective armature circuit resistance of only 20 per cent of the actual resistance. It is interesting to note from Figure 8 that a motor has a considerably larger peak torque with 80 per cent IR drop compensation and 15 per cent voltage than at 50 per cent voltage with no IR compensation.

Curves showing peak torque obtainable and the corresponding current versus per cent speed are shown in Figure 9. With this information, it is possible to determine when an armature circuit booster is required. For example, suppose a reel motor has 5 per cent IR drop and that operation down to 10 per cent speed by adjustable voltage is required with 50 per cent torque necessary for acceleration. Since it is desirable to have 100 per cent of the motor torque rating available for carrying the load, a total of 150 per cent torque is required during acceleration. Referring to the curve in Figure 9, a motor with 5 per cent IR drop has available only about 110 per cent torque at 10 per cent voltage without IR drop compensation. Therefore, for this example it is necessary to have an armature circuit booster with IR drop compensation. It is desirable to review each application to make certain that IR drop compensation is specified when required.

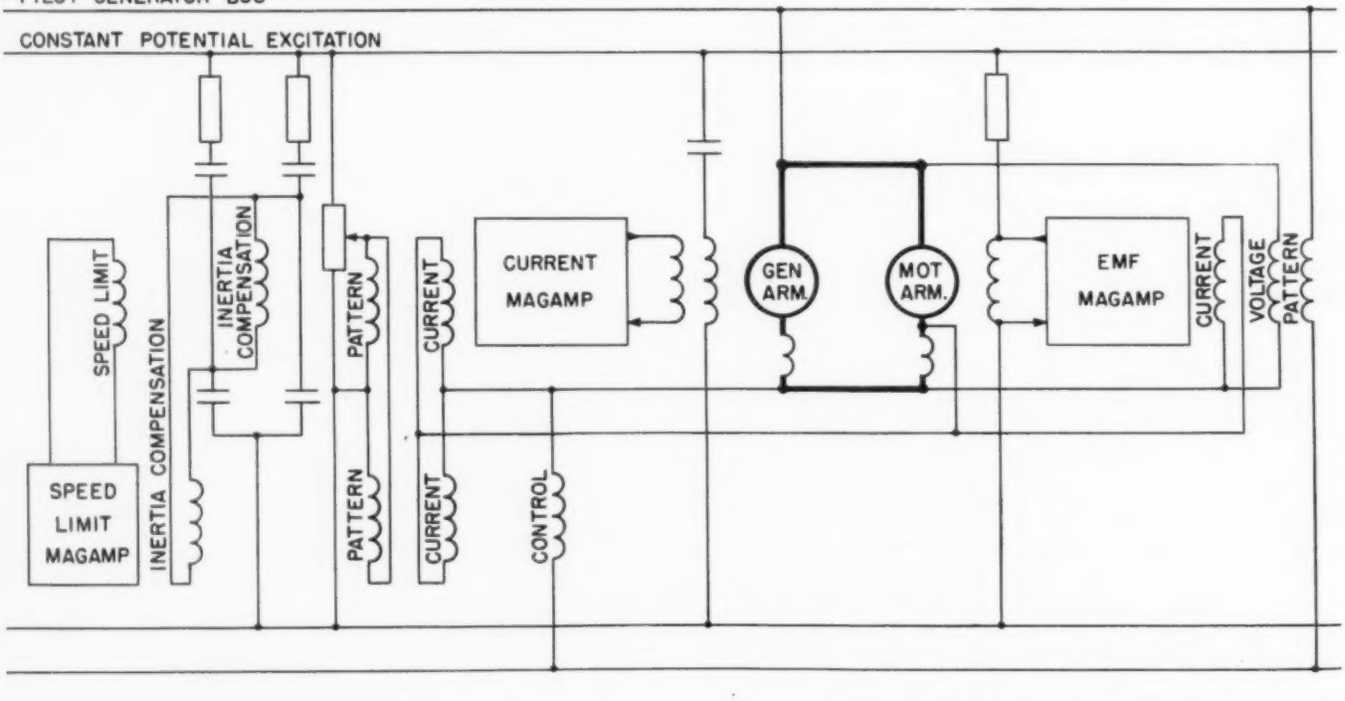
The curves in Figure 9 are for a motor with no armature distortion. There is always some armature distortion, particularly with non-compensated motors. This should be taken into account in using Figure 9. For example, if 150 per cent torque is required, it is best to make certain that at least 175 per cent torque can be developed according to the curve.

MAIN DRIVE SYSTEMS

A reel control scheme which is used for main drive applications is shown in Figure 10. Strip tension between the reel and the mill is regulated by magnetic amplifier regulators. The reel generator is controlled by a magnetic amplifier which regulates for constant reel armature current; the magnitude of this current may be adjusted by means of a rheostat. The reel motor is excited by a magnetic amplifier which regulates for a reel motor counter emf proportional to mill speed; this varies reel motor field strength in proportion to coil diameter. Intelligence indicating strip speed is supplied by a pilot generator connected to the mill motor. The combination of constant armature current and variation of mill motor field strength in proportion to coil diameter gives constant tension at all mill speeds and coil diameters. A magnetic amplifier is used to limit speed of the motor during threading and in case of strip breakage

Reel motor field strength is determined by a magnetic amplifier which regulates for a counter emf proportional to mill speed. Minimum field on the motor is supplied from a source of constant potential excitation. The magnetic amplifier which supplies the additional voltage necessary to bring the motor field strength from minimum to maximum, has three control fields: IR drop compensating, voltage, and pattern. The pattern field,

Figure 10 — Constant tension is produced by the combination of constant armature current and motor counter-emf proportional to mill speed for this main drive reel control system.



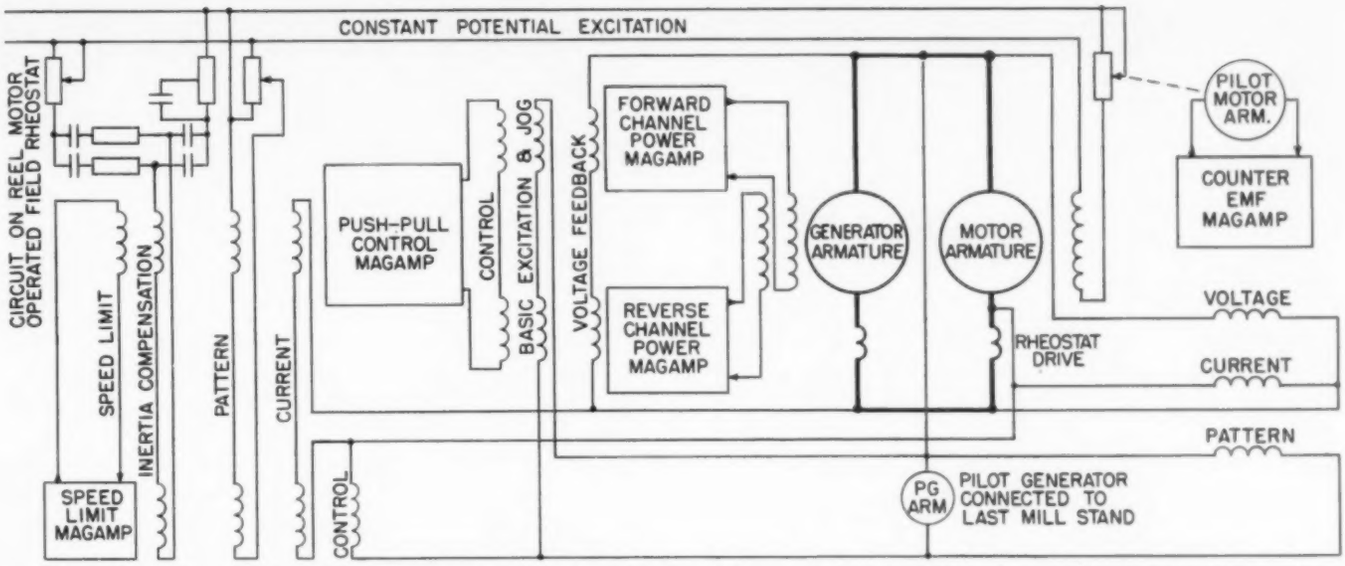


Figure 11 — For a main drive reel requiring the utmost in precision control, a two-stage two-channel magnetic amplifier current regulating system is used, but the principles of operation are exactly the same as for the system in Figure 10.

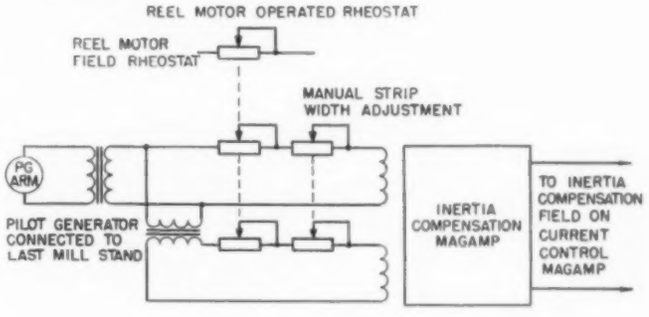
which is connected across a pilot generator connected to the mill motor, is a measure of the counter emf required. The motor counter emf is measured by the difference in strength between the voltage and IR fields. If the counter emf of the motor is below what it should be for a given speed of the mill, the strength of the pilot generator field exceeds the net strength of the voltage and IR fields. This causes the magnetic amplifier to strengthen the motor field until the motor counter emf is what it should be for a given speed of the mill. At the beginning of a coil, motor field strength is weak on a winding reel. As the coil builds up, the regulator output strengthens the field, so that it maintains a counter emf proportional to mill speed.

Reel motor armature current is regulated by a magnetic amplifier which operates on the generator field and has four control fields: pattern, current, speed limit, and inertia compensation. Function of the speed limit field is to limit speed of the reel motor during threading and in case of strip breakage. If the current field strength exceeds that of the pattern field, the magnetic amplifier reduces generator voltage which decreases motor armature current. This process continues until the pattern field strength equals that of the current field. Current for which the magnetic amplifier regulates may be adjusted by a potentiometer type rheostat which adjusts pattern field strength.

To maintain constant tension the inertia compensation field adds to or subtracts from the pattern field strength during the transient conditions of acceleration and deceleration.

When the strip tie between the mill and reel does not exist (when the strip breaks or during threading), the only way motor armature current can be maintained is for the motor to accelerate. The speed limit magnetic amplifier limits speed of the reel motor under this condition. This regulator has control, current, pattern and inertia compensation fields. Output of the speed limit magnetic amplifier is unidirectional and goes into the speed limit field of the current regulating magnetic amplifier. The control field is connected so that it measures the difference in voltage between the generator armature and the pilot generator on the last mill stand. During threading the reel generator voltage exceeds the mill pilot generator voltage, and the voltage difference causes a current to flow in the speed limit magnetic amplifier control field circuit. When speed of the reel motor is what it should be for a given speed of the mill, the output of the speed limit magnetic amplifier is zero. When speed of the reel is above what it should be for a given speed of the mill, output of the speed limit magnetic amplifier is in a direction to circulate current through the current regulating magnetic amplifier speed limit field. When the strip tie between the mill and reel does not exist, the current regulating magnetic amplifier raises reel generator voltage until the combined strength of the speed limit and current fields equals that of the pattern field. When speed limit action is taking place, the combined strength of the speed limit magnetic amplifier control and pattern fields cause the regulator to have sufficient output to limit speed of the reel motor. When the strip is wrapped on the reel through the action of the belt wrapper, current in the motor armature circuit increases to the value which the current regulator is set to maintain. The current field of the speed limit regulator then causes the output of the speed limit magnetic amplifier to go to zero. The pattern and current fields on the speed limit regulator recalibrate the system, so that the same overspeed is maintained regardless of the current for which the current regulator is set to main-

Figure 12 — Where inertia compensation requirements are critical, a magnetic amplifier may be used to provide the inertia compensation signal.


REEL MOTOR OPERATED RHEOSTAT
REEL MOTOR FIELD RHEOSTAT
MANUAL STRIP WIDTH ADJUSTMENT
PG ARM
PILOT GENERATOR CONNECTED TO LAST MILL STAND
INERTIA COMPENSATION MAGAMP
TO INERTIA COMPENSATION FIELD ON CURRENT CONTROL MAGAMP

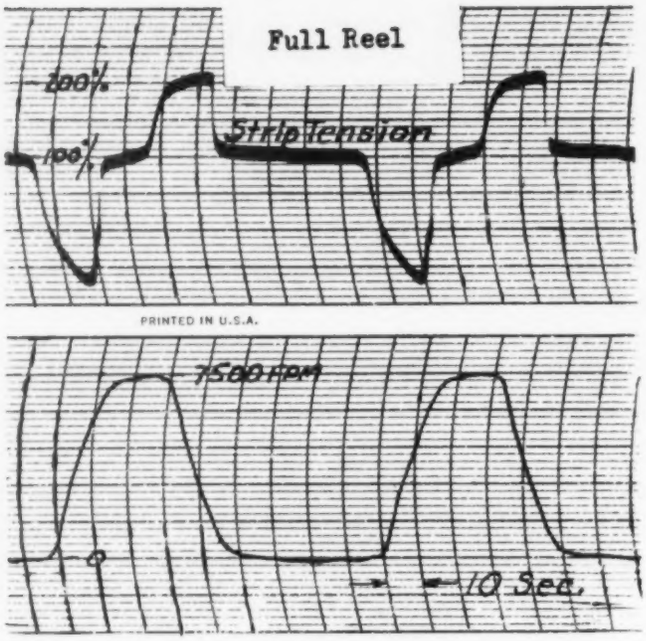


Figure 13 — There is a wide variation in strip tension during acceleration and deceleration when inertia compensation is not provided.

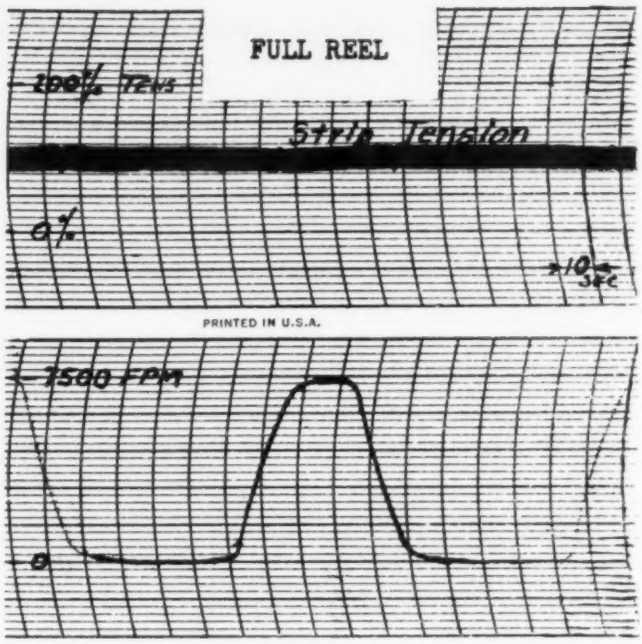


Figure 14 — With ideal inertia compensation, there is no variation in strip tension during acceleration and deceleration.

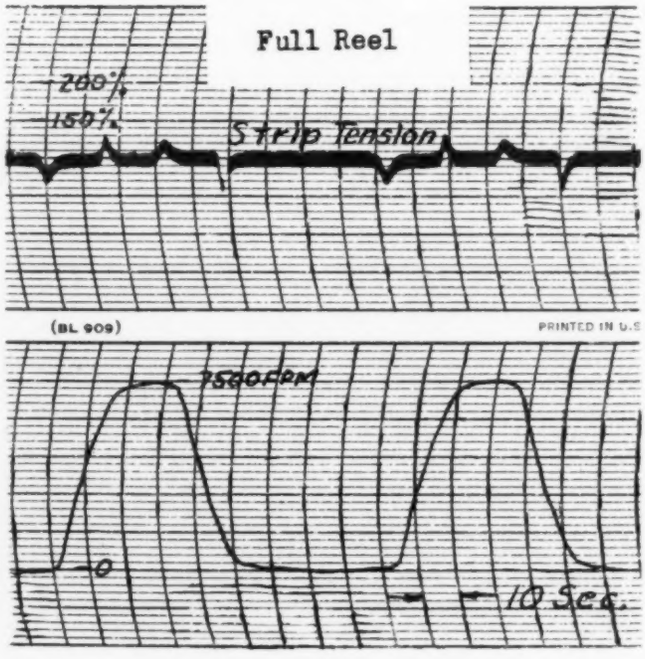
tain. The overspeed during threading is independent of the strength of the pattern field on the current regulator. The speed limit regulator has an inertia compensation field which is excited simultaneously with the inertia compensation field on the current regulator. This recalibrates the speed limit regulator so that it is effective during treatment acceleration and deceleration conditions as well as for constant strip speed.

When the reel does not have a belt wrapper, use of the speed limit magnetic amplifier is optional. Since the strip is clamped to the reel, there is no threading operation during which speed limit action is required. If the speed limit magnetic amplifier is not used, it is desirable to have protection which automatically stops the reel motor if the strip breaks.

The reel generator is provided with a field which is excited from constant potential excitation and which is connected differentially. During normal operation, the effect of this field is cancelled by the excitation in the main field which is connected to the current regulating magnetic amplifier. Since the current regulating magnetic amplifier has unidirection output, this differential field excited from the constant potential excitation is necessary to insure good regulation at low voltage and to provide additional forcing for transient conditions when a decrease in generator voltage is required.

For main drive applications which require the utmost in precision control and speed of response, the scheme shown in Figure 11 is used. The basic principles of operation are exactly the same as described for the scheme shown in Figure 10. This scheme has a two-stage, two-channel magnetic amplifier regulating system for maintaining motor armature current by regulating generator voltage, while the simpler scheme has a single-stage, single-channel magnetic amplifier for this purpose. The magnetic amplifier which controls strength of the reel motor field operates a motor operated rheostat which varies field strength. It is only necessary to vary reel motor field strength as coil diameter changes. Since this is a slow change, a motor operated rheostat is ideally suited to the application. The motor operated rheostat gives an indication of coil diameter which can be used to modify the inertia compensation signal in accordance with the coil diameter. This is accomplished by a circuit on the field rheostat which is connected in series with the inertia compensation field on the current regulating magnetic amplifier. The two stage, two-channel magnetic amplifier system which is used to regulate for armature current gives maximum accuracy and speed of response.

Figure 15 — When inertia compensation is limited to a signal proportional to the rate of change of mill speed, there is an error in strip tension at the beginning and the end of a strip speed change.



INERTIA COMPENSATION

Where inertia compensation is extremely critical, a scheme such as shown in Figure 12 may be used. The inertia compensation fields of the magnetic amplifiers which control motor armature current are energized by a magnetic amplifier which is designed especially to provide the inertia compensation signal. The inertia compensation magnetic amplifier has two control fields. One field is energized through a transformer connection to the pilot generator connected to the mill stand, which means that it receives a signal which is proportional to the rate of change of mill speed. The other field is energized by a signal which is proportional to the rate of change of mill acceleration; this signal is obtained by connecting a transformer across the secondary of the transformer which gives the signal indicating rate of change of mill speed. Circuits on the motor operated rheostat which varies reel motor field strength are connected in series with each of the magnetic amplifier control fields to change the signal in accordance with coil diameter. This system gives extremely accurate inertia compensation.

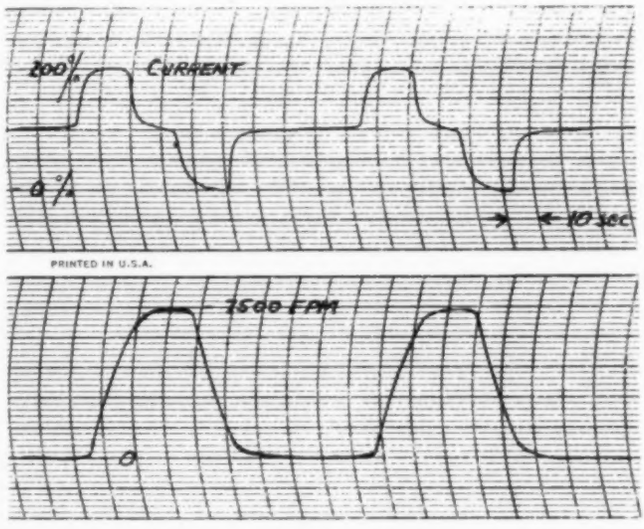


Figure 16 — When strip speed is changed, motor armature current is modified to hold constant strip tension.

There can be a tremendous variation in tension when inertia compensation is not provided. This is shown in Figure 13 which is an oscillogram taken on an analogue computer. How inertia compensation eliminates this tension variation is shown by the oscillogram in Figure 14 which is for the same system, but uses the inertia compensation system which is shown in Figure 12. If the inertia compensation is limited to a signal which is proportional to the rate of change of mill speed, there is a transient error in tension at the beginning and at the end of a mill speed change as shown by the oscillogram in Figure 15. At the beginning of an acceleration the tension momentarily drops below the regulated value, and at the end of the acceleration the tension momentarily goes above the rated value. The second field on the inertia compensation magnetic amplifier receives a signal proportional to the rate of change of mill acceleration and provides an anticipation effect which eliminates the momentary changes in tension at the beginning and end of the change in speed of the mill. Variation of reel motor current with ideal inertia

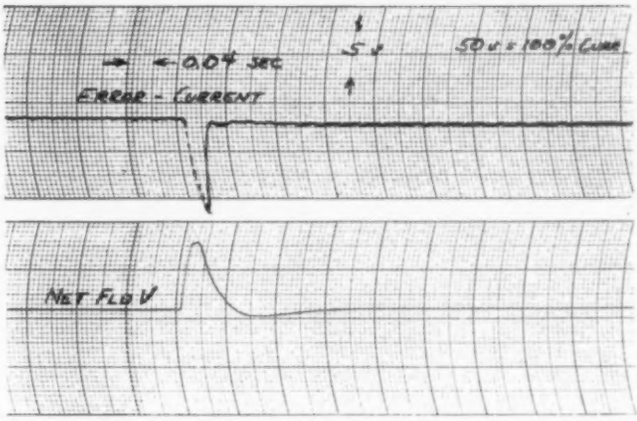


Figure 17 — When a disturbance is introduced, the reel motor armature current regulating system makes complete correction in 0.04 sec.

compensation is shown in the oscillogram of Figure 16 which was also made on an analogue computer.

A full scale combination test of a complete magnetic amplifier regulating system for a tandem cold mill stand drive was made at our East Pittsburgh Works in 1951. Since that time, two complete magnetic amplifier tandem cold mill drives have gone into operation. It is important that the reel control system response is at least equal to that of the mill stand generator regulating system. The response of a modern magnetic amplifier reel current regulating system is shown in Figure 17 which is an oscillogram taken at the installation shown in Figure 18. When an instantaneous reference disturbance is introduced, the system makes complete recovery in about 0.04 second and is critically damped.

Because they are static devices which require practically no maintenance, magnetic amplifiers have gained quick acceptance in the industry. The absence of bearings, brushes, and commutators is a distinct advantage. Installation is more economical because magnetic

Figure 18 — A 3200-fpm tandem mill with a complete magnetic amplifier reel control system has been in service at Pittsburgh Steel in Allenport, Pa. for over a year with no maintenance required.

amplifier panels are mounted and wired as part of the control equipment at the factory.

A good reel control system requires a scheme suitable for the application plus the right components. The many installations with magnetic amplifiers conclusively demonstrate that they give the precision performance and reliability necessary for main drive and process line reel control systems.

DISCUSSION

PRESENTED BY

C. C. THOMAS, Steel Mill Engineering, Systems Application Engineering Section, General Electric Co., Schenectady, N. Y.

A. J. WINCHESTER, JR., Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

C. C. Thomas: There was a day when any winding reel which held constant current over a reasonable range of conditions was suitable for most applications, and a compromise adjustment could usually be reached which would permit operation without either too frequent looping or breaking of the strip. No longer is this true. With conditions imposed on winding reels becoming more and more severe due to higher speeds, larger coils, wider range of products, and faster accelerating times, it becomes increasingly more important that these basic concepts be fully understood.

As pointed out by the author, cone type uncoiler drag generators can be connected either in series or parallel with the parallel connection appearing to be the most popular. Recently, however, we have had occasion to re-examine this application and have supplied two mills with the uncoiler drag generators connected in series. The basic problem resolves itself to one of armature current division for the parallel connected machines, and of armature voltage division for the series connected machines. In either case should one cone tend to slip, it cannot be forced to take an equal load unless the total load is reduced or the operator adjusts the cones. A circuit to detect either voltage or current unbalance can easily be incorporated into the control to be used to either reduce the back tension or notify the operator that a cone is slipping or both.

One of the more difficult winding reel applications is found on the new high speed tandem cold strip mills. We have recently engineered the winding reel for what will be the highest speed, highest powered tandem cold strip mill in the world. This winding reel will be driven by a 2000-hp, 200/900-rpm, 750-volt motor which will consist of four 500-hp, 375-volt armatures arranged as a double armature twin drive. The large horsepower is required to provide enough tension for heavy sheet products at low speed. Therefore it will be necessary to hold reduced values of tension when running at maximum speed. The coil will be wound on a 16½-in. mandrel to a maximum diameter of 85 in. To accelerate such a coil to better than 7000 fpm in 14 seconds will require more than 2000 hp. The field range on this motor is compressed to be slightly less than the coil buildup based on the reasoning that the minimum diameter will never exist at top mill speed because of the buildup during acceleration. Any actual tension error can be corrected by a recalibration of the inertia compensation horsepower adjustment.

Serious thought including several studies on the electronic analogue computer was given to the selection of components for this difficult application. It was agreed by all that fast response was not only desirable but absolutely necessary. In comparing the all magnetic amplifier system against the combination of magnetic preamplifier and rotating regulator it was decided that the combination system had the most advantages. The response and performance could be made equivalent and the circuitry could be greatly simplified in the combination scheme because of the reversing characteristic of the amplidyne.

Incidentally it would be appreciated if Mr. Winchester would clarify Figure 17. It is not too clear as to just what is being measured in these traces. Apparently the armature current has recovered in 0.04 seconds although the armature voltage continues to change for considerably longer. We have not noticed this phenomenon on any of our reels and I am wondering if I interpret this figure correctly.

A. J. Winchester: Our experience shows that minimum speed of response is obtained with a complete magnetic amplifier regulating system. The three basic systems which are commonly used are complete magnetic amplifier, magnetic amplifier and rotating exciter combination, and rotating regulator and exciter combination, and they are listed in order of increasing response time. We have all three types of systems in operation. Oscillograph tests taken on full scale combination tests at our factory and on installations in the field show that the all-magnetic amplifier system gives performance which cannot be duplicated by the other two systems. In addition, the all-magnetic amplifier system requires a minimum of damping or stabilizing equipment which simplifies field adjustment and maintenance.

The circuits of a magnetic amplifier system are not complicated. A magnetic amplifier panel with its rectifiers and reactors is a component which may be compared to a rotating regulator. On schematic diagrams for magnetic amplifier systems there is a tendency at present to show too much detail, and this erroneously makes it appear that the system is complicated. The armature of a rotating regulator is usually designated by a simple circle, but this circle represents a multitude of connections, coils and commutator bars plus the brushes and bearings. A magnetic amplifier component should be represented by a simple symbol on the main schematic diagram and a separate internal wiring diagram provided the same as a separate wiring diagram is provided for the armature of a rotating regulator.

The reel generator field voltage is the net field voltage shown in Figure 17. The top trace is proportional to reel motor and generator current which is the same since this was taken on a system with individual generator supply. Speed of response is measured by introducing a disturbance and noting the time required for the regulating system to correct. The generator field voltage and armature current are not in phase, and this is normal.

Methods of Increasing Open Hearth Production

By G. W. TESKEY
Open Hearth Superintendent
and
W. L. MURPHY
Fuel Engineer
Bethlehem Pacific Coast Steel Corp.
San Francisco, Calif.

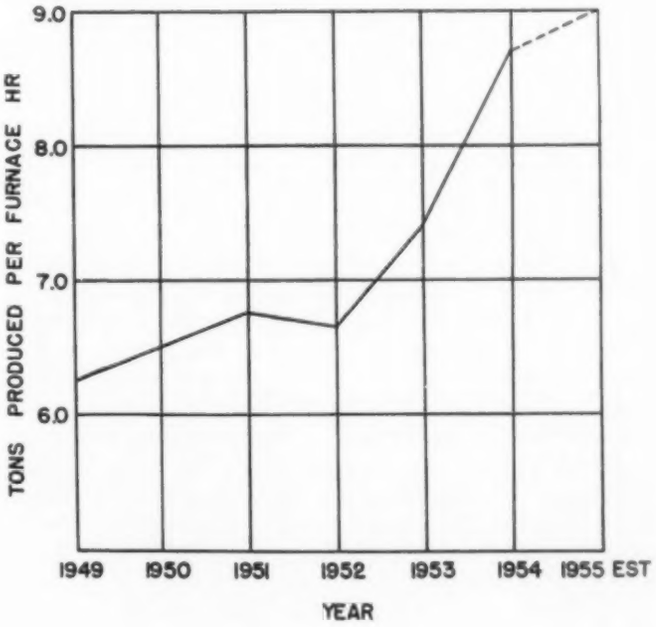
. . . . the ingenuity of the steelmaker is perhaps best illustrated in his ability to increase furnace production, not through new units with their increased capital costs, but through careful attention to the many details which are a factor in furnace operation . . . . details which increase production are such items as maintenance of a maximum material burden, improvements in burner and furnace design, better refractories and cooperation and interest amongst the operating personnel . . . .

▲ THERE are two universal factors which may be applied to measure the efficiency of a given open hearth operation, production rate expressed in terms of net tons per furnace operating hour, and cost of product including both raw material and conversion costs. That an appreciable increase in production efficiency may be possible in a cold metal shop of average size is apparent from the operating data presented in Figure 1. Note that the average tonnage per hour has increased approximately 45 per cent in the past five years. A study of some of the major variable cost factors entering into such an operation will indicate that cost of product has also declined during these years.

During and after World War II and the Korean conflict, the emphasis on higher production rates in the steel industry, combined with technological improvements, has resulted in a general increase in open hearth operating efficiency throughout the country. The shop under consideration does not necessarily represent a unique operation. The developments represent the national trend.

Prior to 1950, this shop was equipped with inadequate ladle cranes which prohibited the increase of heat size to the full capacity of the furnaces. Replacement of these cranes, reinforcement to the pit building, addition of larger ladles, and minor pit changes permitted a 25 per cent increase in the tonnage tapped per heat. This modernization program resulted in a moderate increase in the productivity of the shop. New, better, and more modern equipment should certainly yield an increase in production; however, the purpose of this discussion is to investigate those operating practices which accounted for the increases not directly attributable to capital expenditure. From an analysis of the practice during the years of increasing productivity, an attempt will be made to explain the considerations which led to this progressive development. Some 36 factors were studied to determine what changes had occurred and what correlation existed between these factors and production efficiency and costs. Due to the complex relationship of these variables, plus those irre-

Figure 1 — Average furnace production has increased about 45 per cent in the last five years.



ducible elements of operation which cannot be expressed numerically, it is obvious that a precise evaluation becomes difficult. However, the attempt was made, and this paper is primarily devoted to an interpretation of this analysis.

The cold metal shop being studied consists of five 75-ton furnaces with an annual rated ingot capacity of 300,000 tons. Figure 2 shows one of these units. Overall length inside brickwork is 50 ft-7 in.; width inside brickwork is 11 ft-6 in. Bath dimensions are 10 ft-6 in. by 30 ft-6 in. by 2 ft-6 in. deep. Auxiliary furnace equipment includes water-cooled doors and frames, water-cooled combination gas-oil burners, dry-type butterfly reversing flue valves, and instrumentation including fuel-flow recorders and controllers, furnace-pressure control, roof and checker-temperature measurement, and automatic furnace reversal. On demand the shop has produced low-alloy heats, synthetic bessemer stock, etc. However, the normal product range consists of plain carbon steels with carbon ranging from 0.05 to 0.95. About 50 per cent of the product is rimmed and 50 per cent killed or semi-killed steels.

When analyzing the problem of increasing production, it was apparent that the initial approach must involve an increase in the tonnage of the raw materials charged into the furnace without an increase in the time to convert these materials. In addition, this larger burden was not to consist of more costly materials which would consume the savings resulting from an improved production rate. With this latter point in mind the burden was increased progressively in 1950, from 130,000 to 165,000 lb. Material cost was controlled. The second phase of the program, that of maintaining or reducing furnace time to convert this larger burden, was undertaken simultaneously.

In attempting a reduction in time to convert the material, an obvious consideration is heat. Heat is a primary factor affecting conversion time. The modern concept of operation is that increased heat release rates should result in a decrease in the production time. Therefore, the average fuel input rate was gradually raised from 200 to 300 gphr of oil equivalent. Such an increase in fuel input could result in a serious decrease in total furnace availability due to excessive burning of endwalls, sidewalls, roof, and checkers; in fact, the entire furnace system. Before a change in fuel input is successful, all of the factors immediately associated with fuel have to be considered. Until these factors were satisfactorily adjusted, furnace life did decrease and expected production rates were unattainable.

To overcome endwall erosion and overheating of the checkers, the additional fuel had to completely burn over the hearth, rather than be allowed to sweep across the furnace into the downtakes and checkers, as was the tendency, particularly when natural gas was fired in combination with light fuel oil. An analysis of the flow rates in the furnace resulted in a redesigned burner and a reduction of the furnace throat area. These changes added velocity to the gas-oil stream, promoting turbulence and better mixing of the fuel and the preheated air. The throat area was decreased 25 per cent by raising the bridge wall and installing monkey walls on front and back sides of the furnace. The burner dog houses were eliminated and, contrary to past practice, the burner was well withdrawn from the port block. These considerations resulted in a sharper, more easily controlled flame and greatly reduced the tendency to burn endwalls and checkers. The burners were then mounted on newly designed support brackets which permitted only limited changes of burner position, thus minimizing the possibility of severely damaging the furnace from careless or accidental burner positioning. The latter point is important on cold metal furnaces where raising and lowering of the burner is required during the charging period.

The new, more intense flame tended to increase skewback and tapping side roof erosion. This difficulty was overcome when the furnace pressure was substantially increased from a slight blow at the furthest door from the burner to a heavy blow at all three doors. A corresponding adjustment in the fan-induced combustion-air flow caused the flame to burn lower in the furnace, increased the heat transfer at the scrap line, and eliminated premature failure of the roof and skewback areas.

An experiment varying the ratios of natural gas to oil was conducted to determine the effect of natural gas on the production rate and to establish maximum amount of gas that could be fired. From these tests a ratio of 50 per cent gas and 50 per cent light fuel oil was found to be best for this operation. A further increase in the gas ratio, which of course is desirable because of the relative cost of the two fuels, must await further improvement and refinement in furnace and burner design. A routine fuel firing practice was then established and individual changes from this schedule were discouraged except under very unusual conditions. Thus, with these considerations, a substantial increase in fuel rate was accomplished with no detrimental effects upon refractories or furnace availability.

The checker burning problem mentioned above led to a complete analysis of this area, not only with the aim of improving refractory consumption but also from the standpoint of providing maximum air-preheat. The checker chambers in this shop are relatively small, having a maximum heating area of 10,000 sq ft and a total volume of 2600 cu ft. The study indicated that checker temperatures ran either considerably cooler than was desired or, conversely, dangerously hot, and checker brick consumption was abnormally high. In order to eliminate burned checkers, new temperature recorders, which incorporated a high temperature reversing switch, were installed. Experiments with vari-

Figure 2 — This five furnace shop has an annual ingot rated capacity of 300,000 tons.

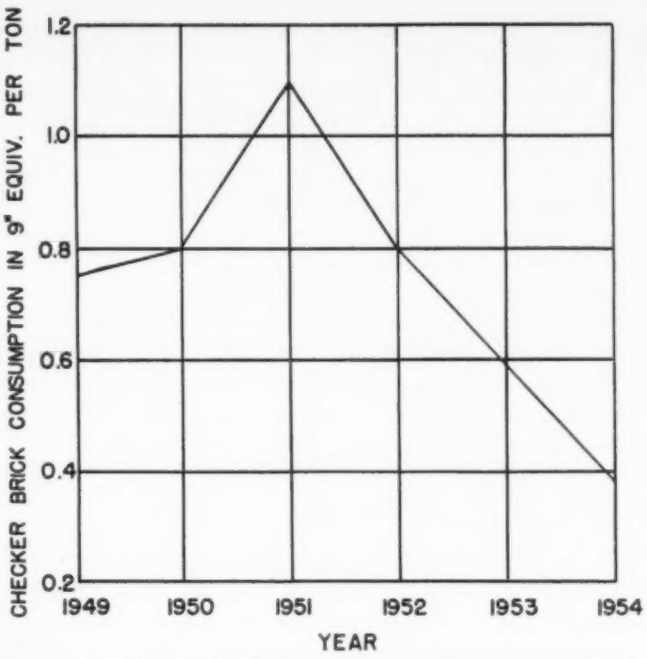


Figure 3 — Annual checker brick consumption has been cut almost in half in the past five years.

ous time cycles were conducted, with the result that optimum reversal time was set at ten minutes rather than fifteen.

This reduction in the time cycle not only reduced the tendency of the checkers and endwalls to overheat, but also permitted a higher average temperature level to be maintained. Higher average checker temperatures, the reduction in cold air infiltration resulting from the higher furnace pressures, and a more concerted effort to keep the regenerators sealed, undoubtedly provided a much higher preheat to the combustion air. An effort is made under the present operation to maintain maximum combustion air preheat by running checker temperatures at a maximum safe level, with the automatic high temperature safety switch reversing the furnace from one to several times per heat under optimum conditions. Figure 3 graphically illustrates the decrease in checker-brick consumption in recent years as a result of these considerations.

The next group of factors that were considered separately, though simultaneously, involved refractories in general. Again a criterion had to be established. In this case it was decided that the optimum operation would result if a furnace design could be evolved so that none of the components required down-time repairs during a campaign.

With this goal in mind, changes in the slag-pocket design were made to increase the volume to the limit permitted by building restrictions. The time when these pockets were filled was established as the practical limit of a campaign. Experimentation with various roof brick and roof design was conducted by comparing panels of one type with another in the same furnace. From this work a furnace-roof design and type of brick were selected which were economically practical and which yielded the same life expectancy as the slag pockets. The development of endwalls that were economical and did not require hot patch repairs during a campaign also necessitated considerable experimentation. The ideal endwall construction for this shop was

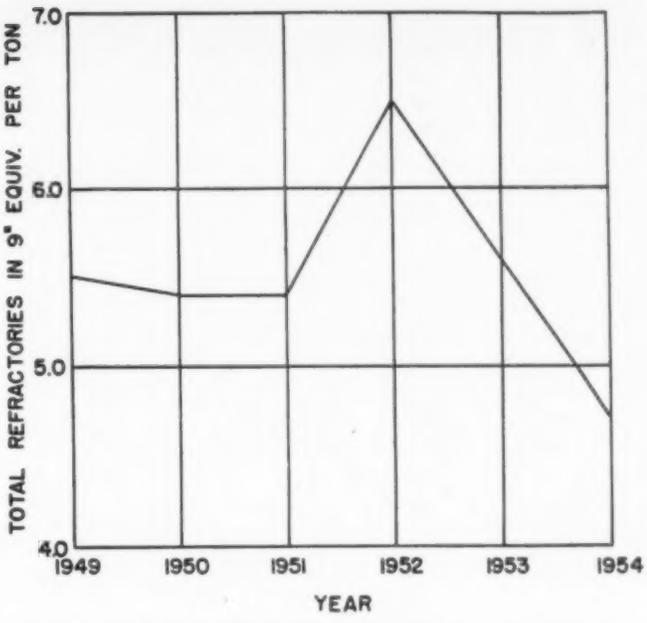


Figure 4 — Total refractory consumption has been appreciably reduced.

found in the application of silica brick for the charging side bulkhead, and a 9-in. panel of fired basic brick for the tapping side. These latter bricks are reinforced with ¼ in. plates every other course.

Watercooled door frames were redesigned to improve their life and rigid inspection of these frames was made standard practice at the end of each campaign. In this case more than average maintenance is performed to produce a frame of assured performance. Trials involving different types of watercooled doors and linings resulted in an economical selection requiring the changing of doors once midway in the campaign and again at the end of the campaign. These efforts and considerations resulted in a furnace life requiring virtually no lost time for hot repairs from fire on to fire off. Front and backwalls are 9-in. chemically bonded basic brick which normally last the full campaign without repairs.

Figure 5 — Reducing furnace delays has added to production.

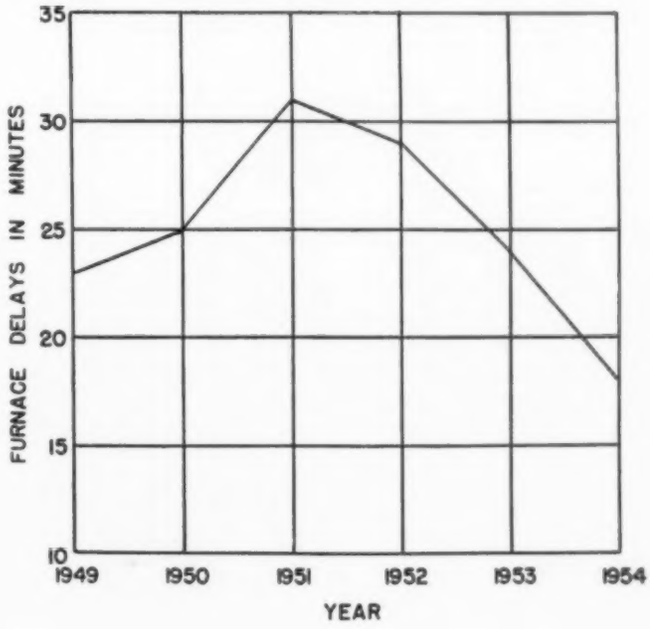


Figure 4 illustrates the average refractory consumption in recent years. Although the above mentioned considerations are reflected in these figures, the undeniable progress exhibited by the refractories producers in improving the quality of their product on the West Coast must also receive a large share of the credit.

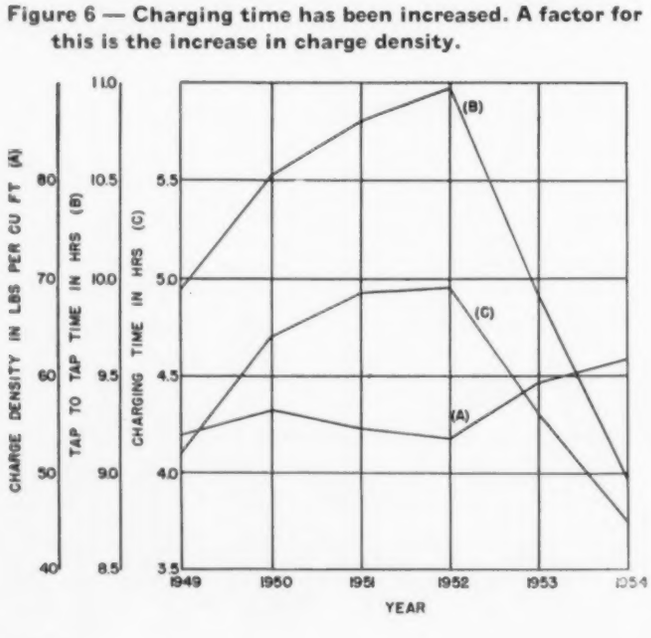
The introduction of bath pyrometry reduced pit scrap loss to a minimum. With the exception of an occasional forced tap, loss of tonnage due to cold pours has been eliminated. Conversely, ingot mold life has increased 5 per cent through the elimination and control of excessively hot heats which score molds and lead to early failure. The effect of a hot heat soaking in a furnace is very detrimental to furnace bottom and banks. Hence reduced bottom delays, as well as some reduction in tap-to-tap time, was effected through the ability to control tapping temperatures.

Figure 5 illustrates the reduction in furnace delay time in recent years. Although refractory application and pyrometric control are reflected in this improvement, the primary contributors have been the new quick-setting refractories of West Coast manufacture and the oxygen-lancing method of bottom repair.

Now, to review, this paper has discussed: (1) combustion practice, (2) furnace design, (3) refractory performance, and (4) instrumentation. All of these items were considered and adjusted in an effort to provide the furnace operators with an efficient production tool; that is, a sharp working furnace. The next consideration is therefore the development of operations which permitted the personnel to achieve the maximum potential from these units.

During the time covered by this study, numerous closely controlled experiments were conducted employing such features as oxygen for combustion, auxiliary compressed air injection, heavier grade fuel oil, and specially developed fuels with additives. Aside from the direct information obtained, these tests tended to engender greater interest among the operating personnel as a whole. This interest to aid, develop, and contribute to a more efficient open hearth was gratefully received by management. As a result of this acceptance of responsibility, a more consistent pattern of operation was developed by the furnace crews. Standardized methods for making bottom repairs, working a heat, and charging were developed, and team work prevailed more strongly. The individual practices of first helpers and melters were adopted, or rejected, by the whole as those best to use to produce the greatest ingot tonnage. From this attitude a considerable improvement evolved covering the entire operating practice. The sincere cooperation of personnel and their acceptance of responsibility can not be overemphasized as a vital consideration in an open hearth operation.

Figure 6 — Charging time has been increased. A factor for this is the increase in charge density.



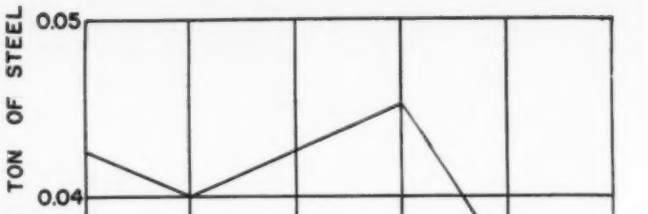


Figure 7—A thinner flux enables faster heating of the bath.

The direct relationship between charging time and tap-to-tap time was illustrated to the furnace men during the fuel trials, with the result that the operating personnel has made a concerted effort to reduce the charging time. Figure 6 illustrates a 25 per cent reduction in charging time during the last four years and a corresponding 20 per cent reduction in the total heat time. Also noted here are the variations in scrap density that have occurred during the same period. A recent statistical analysis of the furnace practice has proved the relationship between the production rate and the scrap density with the result that every effort is expended to maintain densely stocked charging boxes. In a final analysis the charging time of the furnace is now determined simply by its physical capacity to contain the burden.

At the outset of this discussion it was stated that improved production should not be dependent on the use of a more costly furnace burden. Total iron charged, which at present consists of a heavy grade of excellent cast iron, is held constant for each heat. Iron is used not only to increase average density, but also to reduce the time of the working period which would be lengthened by the use of larger amounts of supplementary carbon. The charge of baled scrap is based on quality requirements of the end-product because of the detrimental amounts of unwanted residual metallics that are usually present in this grade of materials. Heavy melting scrap is considered a premium commodity and is used when quality requirements dictate.

An important consideration affecting production, quality, and cost in an open hearth operation is the flux burden. Therefore, a standard minimum charge of lime and limestone was developed for each grade produced. Due to the more rapid transfer of heat through a thinner slag cover, a faster working period was obtained. Figure 7 illustrates graphically the effects of this control program on fluxes. Despite this lower flux burden, the quality of product was not impaired.

It must be remembered that an entire open hearth shop cannot be immediately converted to incorporate some new method of operation. Because of the many interrelated variables involved, one or more campaigns are usually required to definitely prove the worth of any new operating concept. Hence the developments under discussion did not occur simultaneously but rather over a two to three year period.

Summing up, the increase in operating efficiency experienced in this cold metal shop resulted from the following considerations:

1. The maintenance of a maximum material burden with a minimum flux burden.
2. The inauguration and continuation of the study leading to changes in burner design and furnace design to promote greater heat release rates.
3. Employment of the new and improved refractory materials through analysis, study, and experimentation, with due regard to the economics of their use.
4. Study and adoption of modern instrumentation.
5. Recognition of a sincere and enthusiastic operating personnel, freely offering its experience and intelligence toward an expanding tonnage goal.

As the analytical data of the years were plotted, it seemed at times that some new and startling development should become evident. This was not so. As the survey progressed, what became apparent was that no single factor dominates, rather the end accomplished is a result of the coordinated application of many well known rules and ideas.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Friday, December 16, 1955

Christmas Dinner and Dance
Cocktail Hour 6:30 P.M.
Dinner 7:30 P.M.
Dancing 9:00-12:00 Midnight

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Saturday, December 3, 1955

Christmas Dinner and Dance

Main Ballroom, Hotel Statler, Buffalo, N. Y.

CHICAGO SECTION

Saturday, December 3, 1955

Christmas Dinner and Dance 7:30 p.m.

Gold Room, Hotel Congress, 520 South Michigan, Chicago, Ill.

CLEVELAND SECTION

And

YOUNGSTOWN SECTION

Saturday, December 3, 1955

Christmas Dinner and Dance

Rainbow Room, Carter Hotel, Cleveland, Ohio

DETROIT SECTION

Saturday, December 3, 1955

Christmas Dinner and Dance

Detroit Yacht Club, Belle Isle, Detroit, Mich.

LOS ANGELES SECTION

Friday, December 9, 1955

Christmas Dinner and Dance 7:00 p.m.

Clock Country Club, 14000 East Telegraph Road, Whittier, Calif.

PHILADELPHIA SECTION

Saturday, December 3, 1955 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Preparation of Scrap for Open Hearth Furnaces," by Vernon W. Jones, Superintendent Steel Production, Armco Steel Corp., Middletown, Ohio.

"Plastic Refractories in Preheat Furnaces," by R. A. Smith, Assistant General Foreman 96-in. Hot Strip Mill, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Saturday, December 17, 1955

Dinner 8:00 P.M.

Christmas Dance 9:30 P.M.

Hotel William Penn, Pittsburgh, Pa.

ST. LOUIS SECTION

Data not available.

SAN FRANCISCO SECTION

Friday, December 9, 1955

Christmas Dinner and Dance

Hotel Leamington, Oakland, Calif.

By S. L. JAMESON, Construction Engineering Section, General Electric Co., Schenectady, N. Y.

Ventilation of Steel Mill Equipment

. . . . maintenance is perhaps the most difficult problem to be faced in the ventilation of electrical equipment . . . . dirt is taken out of the air only as long as the filters are kept clean . . . . maintenance of such equipment is vital since it may prevent costly shutdowns of mill equipment . . . .

▲ IT has been stated that the three major enemies of mill equipment and of continuous and uninterrupted service are dirt, heat, and poor maintenance. One of the best weapons to combat these enemies is a good ventilation system. Steel mill ventilation systems include electrical equipment ventilation, whether in motor rooms or as isolated drives, area ventilation for mill buildings, process fume and smoke removal, and cleaning of the air required for manufacturing processes, blowers, etc. This paper is intended to discuss only electrical equipment ventilation, although many of the general problems are the same for other systems.

Modern electrical drive equipment occupies less space for equivalent ratings than did that of 20 to 30 years ago. This increased capacity is partially due to better electrical designs and materials, and partly to better internal ventilation. The modern drive has many small passages through which air flows at a high velocity and large amounts of heat can be removed if the machine is supplied with an ample amount of clean, cool air. Dirt in these passages acts as a heat insulation, or may plug the passage, resulting in a higher machine operating temperature and an accompanying decrease in insulation life.

The primary purposes of a ventilation system are to maintain ratings of the electrical drives, to lengthen equipment life, to reduce failures and maintenance costs, and to reduce costly shutdown. A ventilation system achieving these aims will also normally provide cleaner and cooler operating conditions for plant personnel.

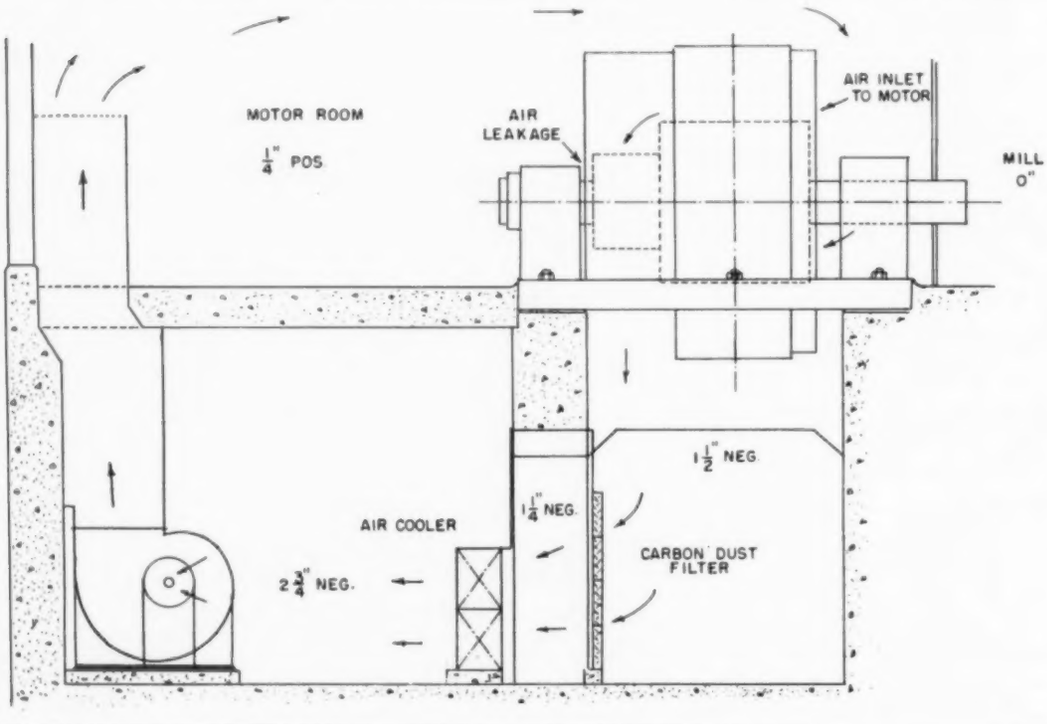


Figure 1 — Schematic arrangement of recirculating ventilation system for drive motor located in motor room. Figures indicate air pressure relative to mill building pressure in inches water. Makeup air required is put into motor room.

GENERAL DESIGN FACTORS

Among the factors to be considered in ventilation system design are prevailing winds, adjacent processes, availability of cooling water, space, normal humidity

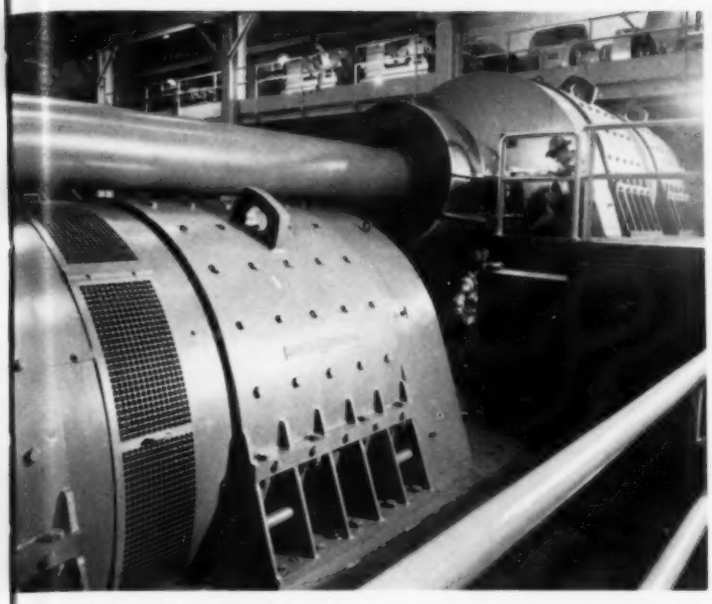


Figure 2 — Blooming mill twin-armature twin-drive motor installed in motor room uses down-draft recirculating ventilation system. Note air intake grills are on the drive end of the armatures.

levels, machine characteristics and operating speed ranges, and maintenance practices.

Normal design practice is to supply approximately 120 cfm air per kw loss in the machine. This results in a temperature rise of 28 F in the air passing through the machine. An increase to 180 to 200 cfm per kw loss is recommended for open machines due to the difficulty of efficiently collecting the heated air discharged from open machines.

Control and operating areas should be on the cool air side of the machines for operating personnel efficiency, as well as comfort.

Typical ventilating air requirements on the 120 cfm per kw loss basis are:

24-in. reversing cold strip mill — 30,000 cfm,

3-strand continuous rod mill — 110,000 cfm,

44-in. reversing blooming-slabbing mill — 200,000 cfm,

60-in. 4-stand tandem cold strip mill — 350,000 cfm.

The direction of air flow through d-c machines is usually in at the drive end and out at the commutator end. This carries brush carbon dust away from the windings of the machine.

The motor room should be as tight as possible to avoid infiltration of dirt. It is suggested that windows be eliminated either by building windowless motor rooms or by using glass blocks instead of windows.

Excess air should be supplied to the ventilating system to maintain a positive pressure and to make up for leakage. The system should be designed so that as much as possible of the overall system is maintained at a positive pressure. A negative pressure should be permitted only in those portions of the system not subject to air infiltration and extreme care should be taken to make these parts of the system as tight as possible.

Ventilation systems may be either of two general types, recirculating or non-recirculating. Either of these systems may be further classified as up-draft or down-draft, depending on the general direction of air flow through the machines.

DOWN-DRAFT AND UP-DRAFT SYSTEMS

A down-draft system is usually preferable in motor rooms since the motor room will then be at the temperature of the air supplied the machine. The air temperature rise through a machine at full load is approximately 28 F and the resulting temperature in an up-draft motor room ventilation system may be too high for efficient operation of auxiliary equipment and uncomfortable for operating personnel. Most people feel that these factors outweigh the possible advantages of eliminating commutator end covers on machines.

Up-draft non-recirculating ventilation is frequently advantageous for motors located in the mill area since the air can be discharged directly from the motor into the mill. This may help with mill ventilation and be of some assistance in fume and smoke control.

RECIRCULATING VENTILATION SYSTEMS

In a recirculating ventilation system air passes through the machine to remove the electrical losses, is cooled in a water-to-air heat exchanger, and returned to the system. Fans external to the machine are usually required to circulate the air.

A schematic recirculating system for a motor room installation is shown in Figure 1. Figure 2 is a photograph of a blooming mill drive motor using the down-draft recirculating system. Figure 3 covers a schematic arrangement of a recirculating ventilation system for a drive motor located in the mill area.

Makeup air should be supplied to a recirculating ventilation system to compensate for air leakage out of the system. It is very important that the makeup air be introduced at the right point in the system to maintain positive pressures at points where infiltration of dirty air might be experienced.

In a motor room type installation, makeup air is generally introduced directly into the motor room. Negative pressures inside machines located in a motor

Figure 3 — Schematic arrangement of recirculating ventilation system for drive motor located in mill area.

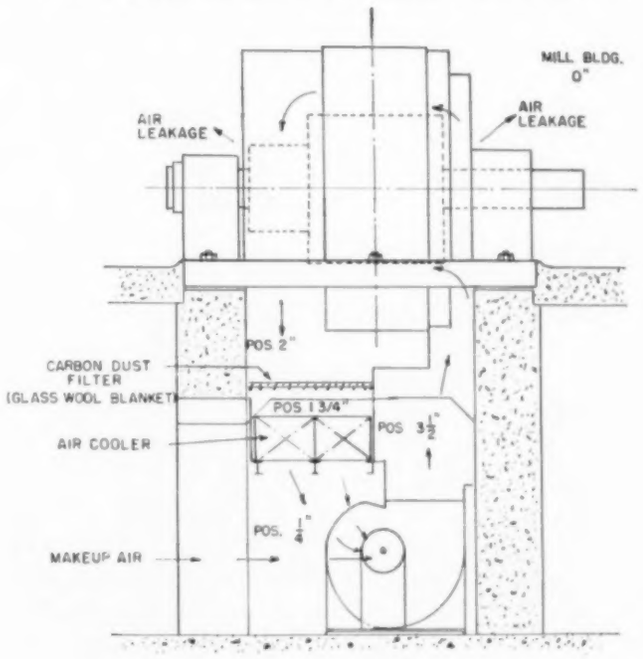


TABLE I

Ventilation Requirements for a 60-in. Semi-continuous Hot Strip Mill

Machine Requirements

	Cfm	
Reversing rougher motor and motor-generator set	183,200	(1)
Six finishing stand drive motors	202,000	
Finishing end basement ventilation (2)	39,000	
Auxiliary motor-generator sets	53,100	
Air required in motor room	477,300	

Air Filter and Supply Fan Selection

	Recirculating system, cfm	Non-recirculating system, cfm
Motor room machines	0	477,300
Makeup air, 10 per cent (3)	47,730	47,730
Adjustable voltage auxiliary drive motors for tables, etc (4)	65,000	65,000
Oil cellars (4)	7,200	7,200
Processing line control room makeup (4)	4,800	4,800
Supply fan and filter rating	124,700	602,000
Approximate overall face dimensions of filter at 90 per cent efficiency (will vary with type)	15 ft 0 in. high x 27 ft 0 in. wide	15 ft 0 in. high x 130 ft 0 in. wide

(1) Based on 120 cfm per kw loss.

(2) To ventilate phase shift and load ratio control transformers for finishing stand drive rectifiers.

(3) Ten per cent makeup is more than 1 cfm per sq ft floor area basis for this mill.

(4) Equipment ventilated by air bled from motor room.

room are permissible since any air leakage into the machine is then filtered air from the motor room. This condition is indicated in Figure 1.

Leakage into a motor in the mill area is normally not permissible since such leakage air is not only dirty, but may also introduce injurious fumes or vapors. In Figure 3 it will be noted that the makeup air is brought into the system at the lowest point of pressure in the recirculating path and, as a result, all points in the system are raised above atmospheric pressure and there will, therefore, be no leakage of mill air into the system. If the makeup air in the system shown by Figure 3 had been brought in at any other place in the system, a negative pressure which would allow infiltration of mill air would result at some point in the system.

Since most of the air in a recirculating system is retained in the system, the required incoming air filter capacity is a minimum. The capacity required is that required to compensate for leakage from the system plus the amount of air which may be bled from the system for ventilation of auxiliary motors located in the mill area. See Table I and the discussion under air filter ratings.

A recirculating ventilation system has the advantage of giving some control of motor room temperature for operating personnel comfort and efficiency through control of the water flow through the air coolers. Due to the smaller filter sizes required, a recirculating system will usually result in minimum overall space requirements.

It is desirable to install carbon dust filters in a recirculating system when possible. This is further discussed under the heading of carbon dust.

NON-RECIRCULATING VENTILATING SYSTEMS

In a non-recirculating ventilating system, air is drawn from outdoors, filtered, passed through the machines, and discharged outside the system. The discharge air duct may be arranged so the air can be recirculated through the motor room to retain electrical losses in the room for winter heating.

Since all air passed through the machines is discharged outdoors during summer operation, the air filtering capacity must be equal to the total machine requirements, plus necessary makeup air to maintain positive motor room pressure. A typical requirement calculation is covered by Table I and is further discussed under the heading of air filter ratings.

Two sets of fans are normally used in a down-draft non-recirculating ventilation system. The first set draws outside air through the filters and discharges cleaned air into the motor room maintaining a slight positive pressure in the room. A second set of fans draws air through the machines and discharges it out of the system.

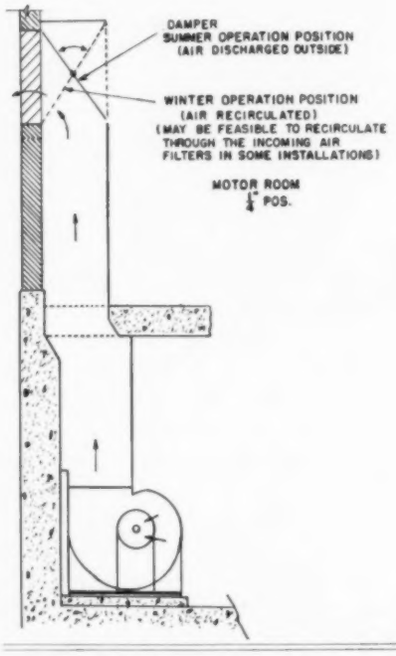


Figure 4 — This arrangement of fan duct for non-recirculating system permits recirculation in winter.

A typical down-draft non-recirculating ventilation system for a motor room would be as indicated in Figure 1 with the air cooler and carbon dust filter eliminated and the fan duct arranged as indicated in Figure 4. Figure 5 shows a cold strip mill motor room using a down-draft non-recirculating ventilation system.

Non-recirculating ventilation for a motor located in the mill area is almost always up-draft. Air enters from below at the drive end and is discharged into the mill at the commutator end. (See Figure 6.) With reference to Figure 3, the coolers would be replaced with a solid barrier and louvers added in the commutator end cover.

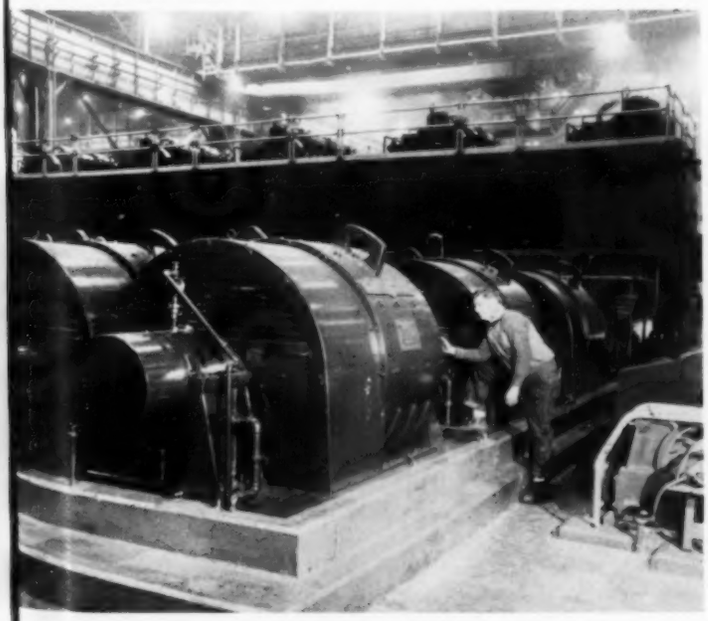
Either one or two sets of fans may be required to circulate the air in an up-draft non-recirculating system. If the air filters can be located close to the equipment, or if the air ducts between the filter and the fans or

Figure 5 — Cold strip mill motor room has down-draft non-recirculating ventilation system. Air filters and intake fans are located in balcony at far end of room. System is arranged for recirculation of air discharged from machines in winter, with recirculated air passing through intake filter.

between the fans and the machines can be installed completely air-tight, one set of fans may be sufficient. Normally these fans would draw air through the filter and supply the necessary pressure to force the air through the machine. This results in a negative pressure area between the filters and the fans which must be maintained air-tight to prevent infiltration of dirty air. Two sets of fans may be required in installations where it is necessary to install the filters some distance ahead of the machine fans and where it may be difficult to make the connecting air ducts completely air-tight. In this connection, it is well to note that it is desirable to keep the machine fans as close to the machine as possible to keep duct work at a minimum.

An up-draft system may make it possible to eliminate the second set of fans in a motor room installation by drawing air through the filter into the basement of the motor room and discharging the air up through the machines into the motor room. This will, however, result in a hot motor room and the extra cost of the second set of fans may be more than compensated for by the better operation of controls, auxiliary equipment and by the increase in operating personnel efficiency and morale which is obtained by a cooler motor room. It is also desirable to have control panels mounted ahead of the d-c machines where possible in order to eliminate carbon dust deposits.

Figure 6 — Tandem cold strip mill drive motors installed in the mill area use up-draft non-recirculating ventilation system. Note air discharge louvers in commutator end.



COMBINATION SYSTEMS

Many ventilating systems are a combination of recirculating and non-recirculating systems and also a combination of up-draft and down-draft systems. A recirculating system may be used for equipment located in a motor room, with a non-recirculating system for equipment located in the mill area.

VENTILATION OF ISOLATED MOTORS

Ventilation must frequently be provided for motors which are either isolated from the main ventilation system or which can not be readily connected to the main system due to their physical location. The system to be used in such cases will vary with the size of motors and with the physical conditions of the installation.

1. A large motor may be ventilated as indicated in Figure 3. Makeup air may be supplied through a relatively small duct, with the motor fan providing the necessary suction to draw in the makeup air. A negative pressure is permissible in the pit provided the pressure at both end covers of the machine is positive. For example, in Figure 3 a maximum negative pressure of 1¼ in. would be permissible at the fan inlet.

   Makeup air may be eliminated. In this case it must be recognized that the system will reach a balance with some air leakage out at the drive end cover and in at the commutator end cover. This may be permissible in some applications, but not in others, depending on the condition of the air leaking into the motor. For example, coolant fumes around a cold mill would soon result in trouble with the motor.
2. The motor may have a built-in water-to-air heat exchanger and air circulating fans. Figure 7 shows a recently designed motor having a carbon dust filter, water-to-air heat exchanger, and external fan built into the base of the motor. This particular design eliminates the need for complicated foundations since the motor assembly can be set on a flat pad.
3. A fan may be mounted on the motor to draw mill air through a motor-mounted filter and force the air through the motor. This scheme is particularly useful on smaller motors operating at reduced speed on adjustable voltage control.
4. An air-to-air heat exchanger may be mounted on the motor with a blower to circulate mill air through one side of the exchanger. Necessary fans to recirculate air through the other side of the

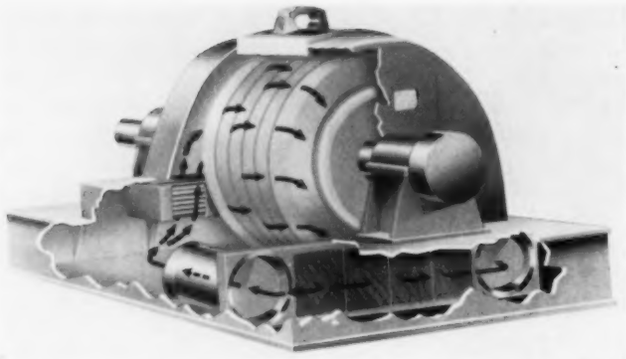


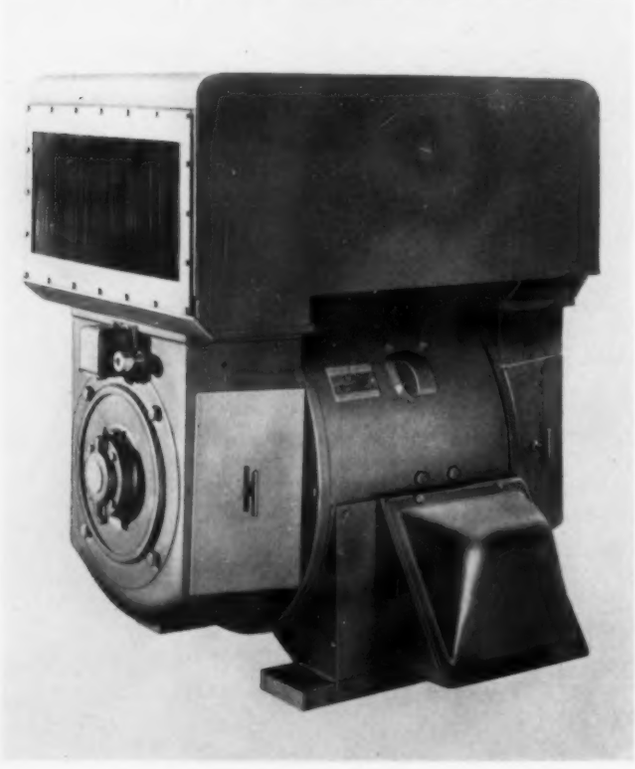
Figure 7 — Mill drive motor with integral recirculating ventilation system. Carbon dust filter, air cooler, and circulating fan are mounted in base. Assembly may be set on flat pad foundation.

heat exchanger and through the motor windings may be built on the motor rotor, or may be a separate fan mounted on the motor, depending on the particular application. See Figure 8.

VENTILATION OF ROOMS WITH OPEN EQUIPMENT

In most motor rooms the heat loss from open equipment is a small percentage of the total, and no special provisions need be made for ventilation of such equipment. Ventilation of rooms in which most of the losses are from open equipment will require a room ventilation system. Such a system usually results in some recirculation of air in the room, and it is therefore suggested that the normal 120 cfm per kw of loss be increased to 180 to 200 cfm. Exhaust louvers should be placed as close as possible to major heat and dirt generating sources to minimize recirculation of heated air.

Figure 8 — Totally enclosed unit cooled motor for auxiliary drives has unit cooler (air-to-air heat exchanger) with necessary fans mounted on main motor.



VENTILATION OF ENCLOSED AUXILIARY AREAS

Auxiliary areas such as control pulpits and oil cellars may be ventilated from the motor room system in many installations. Very satisfactory results have been obtained by forcing 8 to 10 air changes per hour into the oil cellar, letting the air discharge up stairways, etc., into the mill. This prevents heat buildup and helps remove oil vapors.

BALANCING PRESSURE DROP

In either recirculating or non-recirculating ventilation systems, care must be used in paralleling machines on a common system. There is no difficulty in paralleling duplicate machines operating at the same speed, but caution should be used in paralleling machines of different sizes or duplicate machines operating at different speeds. The pressure drop through a multi-speed motor is a function of speed, and the speed range and general operating requirements of the motor must therefore be taken into consideration in paralleling such machines.

There are many factors in the design of rotating machines and one of the most difficult factors to control is the actual pressure drop through a machine. Normally the designer will specify the maximum pressure drop to be expected. Tests have been made on machines in which the actual pressure drop was much less than that specified, and in some cases was negative, indicating a net fan action. Where machines of differing sizes, or duplicate machines operating at different speeds have been paralleled on the system, an in-operation check should be made, and additional baffles installed if necessary for proper air distribution to the various units.

In recirculating ventilation systems, the air coolers may be used as flow equalizers to help insure proper air distribution through the various machines. This is done by providing an individual air cooler for each machine and making the pressure drop through the air cooler plus the specified drop through the machine a constant. The machine-cooler combination can then be paralleled on a common fan system. Any variations in the expected pressure drop through the machines will then be compensated to some extent by the pressure drop through the cooler. A slight excess fan capacity for such a system will insure that any increase in air flow through an individual machine due to a low pressure drop in that machine will not starve other machines.

LOCATION OF INTAKE AIR DUCTS

The location of the intake air duct, whether for makeup air in a recirculating system or for the entire air requirement in a non-recirculating system, should be given serious study. The proper location of the intake may result in lowering the amount of dirt drawn into the system and the load on the air filters and may also help keep injurious fumes out of the motor room.

Prevailing winds should be considered to avoid picking up dust and fumes from adjacent processing areas or from neighboring industries whenever possible.

The bottom of the air intake should be at least 10 ft above ground level to avoid picking up surface dirt.

If it is necessary to locate the intake so that sharp bends or high velocities will be required in the air duct

ahead of the filters, baffles may be necessary to establish uniform air distribution over the face of the filters. An in-operation check is suggested in such installations since most filters — especially the electrostatic type — are quite sensitive to air flow distribution. Uniformity of air flow over the face of the filter is necessary for efficient filter operation and any channeling of air flow through the filters will reduce overall filter efficiency and tend to aggravate oil carryover.

MAKEUP AIR REQUIREMENTS

As previously mentioned, makeup air is required for either recirculating or non-recirculating systems in order to maintain a positive pressure in the system and to prevent infiltration of dirty air. The amount of makeup air required and the pressure maintained are, of course, a function of the tightness of the motor room construction and of the number of necessary openings and the care with which these openings are kept closed.

As an arbitrary rule, a makeup air supply equivalent to 10 per cent of the total quantity of air circulated through the electrical machines is normally considered the minimum requirement. Many installations have an unusual amount of switchgear in the motor room or may use rectifiers for the main mill drive power supply. In such cases the amount of air required for circulation through rotating machines may be comparatively small and the 10 per cent rule for makeup air results in a quantity of air inconsistent with room size. In considering the size of the room as a factor in makeup air requirements, it is recognized that room height, wall area, roof area, etc., are all factors in air leakage from the room. Various factors were considered in analyzing a number of installations which have been operating satisfactorily. It was found that the floor area of the motor room gave a reasonably consistent correlation with a makeup air requirement of approximately one cfm per square foot of floor area.

A high rate of air leakage may be experienced from rooms having a large number of doors, hatches, or drive shafts passing through the wall. In such rooms it may be desirable to increase the makeup air to compensate for the leakage conditions.

It is suggested that the minimum makeup air supply be:

1. Ten per cent of the total capacity of fans circulating air through the machines, or
2. One cfm per square foot of motor room floor area, whichever is higher.

AIR FILTER CAPACITY

Filter capacities for normal dirt concentration in steel mill applications are usually based on the manufacturer's 90 per cent efficiency rating. Heavy dust concentrations may indicate the use of two filters, a roughing filter followed by a finishing filter. Further de-rating of the filters may be desirable in some cases. Extreme dust loads, such as at a blast furnace skip house, might indicate the use of a filter rated at several times the actual air flow requirements. Where two filters are used in series, one will usually be an electrostatic type to take out fine smoke or dirt particles, with an impingement type filter to take out heavy particles.

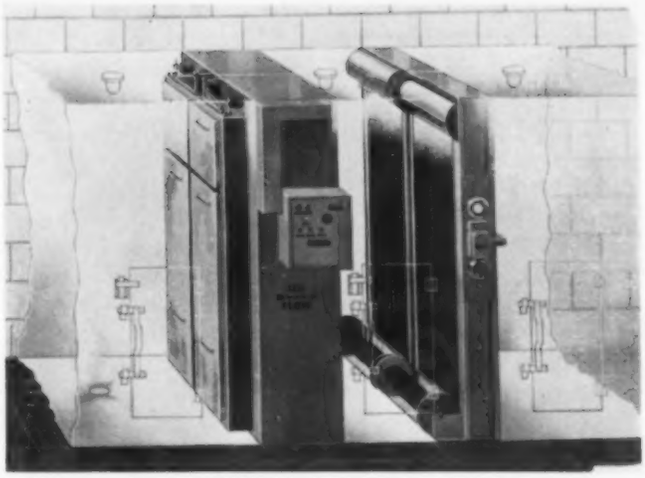


Figure 9 — Electrostatic type air filter shown is used as an agglomerator ahead of an impingement type filter.

Best efficiency is probably obtained with the impingement filter in front. Very promising results have recently been obtained by placing the electrostatic unit in front and operating it with the plates dry. See Figure 9. It then acts as an agglomerator, holding the fine particles until they attach themselves to other particles and blow off as particles large enough to be readily handled by the secondary filter. This practically eliminates maintenance on the electrostatic filter.

In a recirculating ventilation system, the air filter rating should be based on the makeup air requirements to maintain pressure in the room plus the amount of air bled from the room for auxiliary drives. See Table I. In this system the air required by the individual large drives is taken from the motor room, passed through the equipment to be cooled, and returned to the motor room, and any variation in air flow through the equipment does not, therefore, affect the filter directly.

In non-recirculating systems or for air bled from recirculating systems for auxiliary drives, the actual air flow through the machines must come directly from the air filters. The filter rating will then be the total capacity of the fans pushing air out of the system plus a normal excess of 10 per cent for makeup or room pressurizing. If the air pressure drops through the system are appreciably less than the design drop, it may be found that the total air flow has increased considerably and some restriction of air flow is necessary to avoid overloading the air filter. It is suggested that the final installation be checked for air pressure drops and approximate air flows. Air flow may be approximated by measuring fan speed and air pressure drop across the fan using published fan data to determine the corresponding air flow.

PROCESSING FUMES AND DUST

Dust and fumes from processing operations may be extremely troublesome in a motor room and are frequently almost impossible to remove. Corrosive fumes, especially when they create acid in combination with excess moisture, can cause severe corrosion of equipment and may be the reason for commutation difficulties and excessive brush wear. Many kinds of dust in the steel mill are electrical conductors, and in electrical equipment or on controls may cause shorts, grounds or

flashovers. Some dusts are abrasive and therefore cause excessive commutator or collector ring wear.

As an example, the dust and fumes in scarfing operations are extremely troublesome. This dust is not only magnetic, but it is sticky and so fine that it will pass through almost any filter. The problem of scarfing dust removal has been given serious study by several air filter manufacturers, and they came up with a more or less consistent answer — that the scarfing dust can be taken out if you spend enough money to do it and use much more elaborate filter systems than is normal for steel mill ventilating equipment. It is far better to avoid picking up processing fumes and dirt than to try to get rid of them after you have them.

HUMIDITY

Motor room humidification may be desirable in some areas as an aid to commutation and to increase brush life. Recent studies have indicated that the best overall operation is obtained at 40 to 60 per cent relative humidity at 70 F, with a minimum of about 20 per cent relative humidity or 1.5 gr per cu ft for satisfactory operation. An air cooler, even when supplied with very cold water, will not reduce humidity below this range of good operation. Excessive humidity will not cause brush trouble unless corrosive fumes are present, but may cause condensation on motor room walls and equipment. Some excess humidity will be removed by condensation at the coolers in recirculating systems.

Excessive humidity during shutdown periods may cause condensation of moisture in machine windings. Space heaters should therefore be installed under all large machines. An arbitrary rating of 300 kw for generators or 500 hp for motors may be stated as the minimum size on which it is usually economical to install space heaters. Local conditions may occasionally dictate using heaters for smaller machines.

CARBON DUST

One of the problems in recirculating ventilation systems is that of dust from the generator brushes. This dust is not only of a conducting nature, but it is usually extremely fine and therefore difficult to remove with filters. The overall problem is further aggravated by the fact that the worse the filter is needed, the less space there is to put it. In large systems where the air velocity can drop to 100 to 200 fpm, much of the carbon dust may settle out and can be swept up. Many such systems have been operating for years without any trouble. In other systems, air apparently becomes channeled and velocities do not drop low enough to precipitate out the carbon dust and the dust is carried around the system and back into the machine. The problem is particularly aggravated if oil fumes are present or if there is appreciable moisture present. Oil and moisture may cause the carbon dust to cake and make it extremely hard to remove.

Carbon dust concentrations in the recirculating air are fairly low, and for this reason panel type filters have proven quite successful as carbon dust filters. Several such installations are operating satisfactorily and apparently keeping the dust, or at least most of it, out of the machines. In systems where it is not possible to obtain space for a panel type filter installation, it may be possible to install a mesh platform to support a blanket of glass wool filter medium. See Figure 10. The medium can be cut to size and unrolled on the platform like a rug. No such installation is known to be in operation at the present time, but it appears feasible and might very well be an answer to extremely restricted spaces where maintenance of a panel type filter would be difficult, if not impossible. This filter medium can be obtained in rolls up to 5 ft wide.

In any installation the dust filter should be ahead of the air cooler to keep carbon dust off the cooler fins. Condensed moisture is almost always present on the fins of the air cooler tubes and this moisture acts as a binder to cake carbon dust and plug the air passages.

OIL VAPOR

As has been noted above, oil vapor should be eliminated and any oil vapors which may be generated by motor room equipment should be collected and exhausted from the room if at all possible. This problem has been particularly severe in one or two installations in which large gear boxes or pinion stands were located in the motor room. Dirt or carbon dust with an oil binder is frequently extremely difficult to remove.

AIR FILTER SELECTION

The selection of the type of air filter to be used depends not only on the air volume to be filtered, but also on the pressure drop allowable through the filter, dust makeup and concentration, degree of cleaning required, space available, maintenance required, fire hazard,

Figure 10 — Glass wool filter medium is used in blanket form on simple support grid.

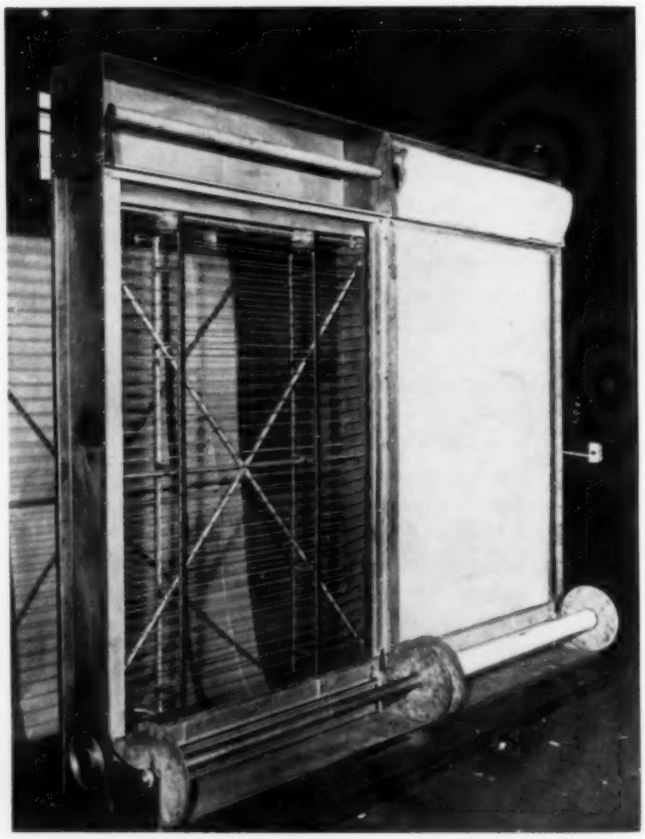


TABLE II

Comparison of Air Filter Types

	Panel filters	Continuous roll	Oil film-self clean	Electro-static	Air washer
Dirt removal from air —					
Very fine dust (0 - 5 micron)	Poor	Poor	Poor	Good	Poor
Fine dust (5 - 10 micron)	Moderate	Moderate	Moderate	Good	Moderate
Heavy dust (Over 10 micron)	Good	Good	Good	Good	Good
Chemical fumes	No effect	No effect	No effect	No effect	Fair
Humidification and evaporative cooling	No effect	No effect	No effect	No effect	Inherent
Dirt disposal	Manual	Manual	(1)	Flush to sewers	Flush to sewers
Winter operation	OK	OK	OK	OK	(2)
Fire danger	Low	Low	(3)	Low	None
Floor space and weight	About equal	About equal	About equal	About equal	Most

(1) Oil cleaning system recommended.
(2) Incoming air must be above 32 F.
(3) Use Automatic fire extinguishing system and/or fire resistant adhesive.

presence of corrosive gases, humidity and occasionally that firmly established factor known as operator's preference.

Three general types of air filters cover almost all electrical equipment ventilation systems:

1. Viscous impingement filters using a multiplicity of adhesive-coated baffles to divide and deflect the air stream and trap the dust particles in a viscous film.
2. Electronic precipitation filters, depending on electrical attraction to remove dust particles from the air stream.
3. Air washers using a fine water spray to trap and carry away the dirt.

A fourth type, dry filtration, involves the use of a medium having small pores and is basically a straining action. It is particularly effective with linty or fibrous dust, especially when an expendable and easily renewed filter medium is used. This type filter has very little application in steel mill systems.

A general comparison of the various types of filters is given in Table II.

AIR WASHERS

Air washers have the advantage of absorbing some chemical fumes and of increasing humidity and providing evaporative cooling. Generally speaking, their overall efficiency in dirt removal is slightly lower than the other types, especially with the smaller dust particles. Protection must be provided against freezing during winter operation, either with heating coils or by recirculating air, or both.

Since an air washer will remove some chemical fumes, a constant discharge from the sump tank is necessary in order to prevent acid concentration buildup in the wash water.

One of the biggest advantages of an air washer is that dirt removed from the air can be flushed directly to the sewer. Component parts, including water nozzles, water eliminator plates and wet glass panel filters, require periodic inspection and manual maintenance.

Air washers may depend entirely on finely divided water spray to remove the dirt from the air, or may be of the wet glass washer type wherein a bank of panel type filters provides additional cleaning (Figure 11). These filters consist of glass wool filter medium with watersprays to provide the necessary adhesive action and to wash away the dirt. These filters will require occasional back flushing and replacement.

MANUALLY CLEANED IMPINGEMENT TYPE FILTERS

The simplest and most flexible type of filter is probably the panel type impingement filter, either of the throw-away or the washable type. Cleaning of this type filter involves either throwing away the individual filter units and replacing with new filters or manually washing the units and returning them to service. Either way the maintenance job is dirty and time-consuming and therefore is frequently neglected. This type of filter is normally used only on small installations or for isolated drives.

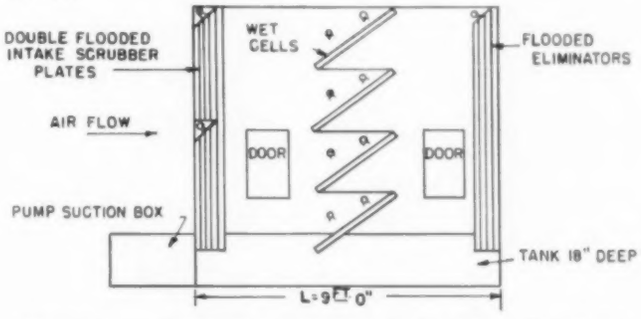


Figure 11 — Wet cell washer for steel mill applications.

A newly announced and interesting development in air filters is one using a glass wool medium in roll form. See Figure 12. The supply roll is placed at the top of the unit and medium unrolled like a window shade across the air path. As dirt accumulates, the medium is advanced and rolled up at the bottom of the unit. When the medium is completely transferred to the lower roll, it is automatically wrapped in a piece of heavy paper. Maintenance and dirt removal then consists of carrying out the used roll, conveniently wrapped, and installing a new roll. The cost of the rolls is slightly higher than normal operating cost for a traveling screen type filter, but is less than the replacement cost for a throwaway type unit. Pilot installations of this type unit have been in operation for about a year in steel mill applications. The unit is being received with considerable enthusiasm due to efficient air cleaning performance coupled with ease of maintenance.

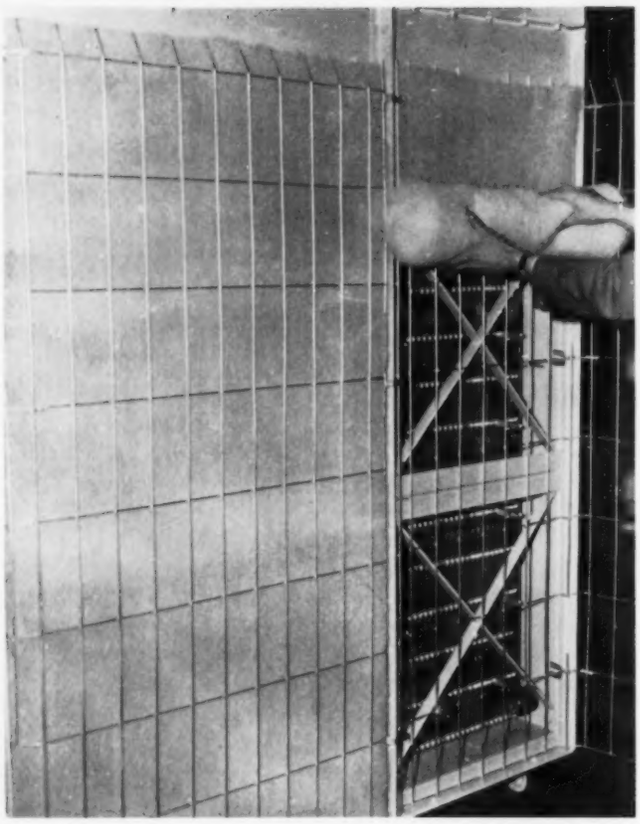


Figure 12 — Continuous impingement type filter using glass wool filter medium.

SELF-CLEANING TYPE IMPINGEMENT FILTERS

Many of the filters used in steel mill systems are of the self-cleaning or automatic type. Regular maintenance is necessary on these units if the automatic features are to remain operative, filter efficiency maintained, and extensive manual servicing avoided. Large deposits of dirt and sludge resulting from poor maintenance will cause faulty filter operation and require filter disassembly and manual cleaning.

Traveling screen self-cleaning air filters may be either of the impingement or electrostatic type. These filters have an oil reservoir at the bottom through which the filter panels pass to remove dirt picked up from the air. The resulting sludge in the oil tank must be removed regularly and the oil kept properly conditioned if the filter is to remain clean and properly filter the air. Excessive dirt accumulation in the tank may result in the filter panels picking up dirt rather than being cleaned. Accumulations of dirt and moisture, with their by-products of sludge and acid, will tend to increase the viscosity of the oil and cause it to cling to the panels. Either dirt or excess oil on the panels causes partial plugging, channeling of air flow, and may result in oil carryover into the ventilation system and into the electrical equipment.

In older installations the accumulated dirt was removed from the filter tank with a hoe. This was a dirty operation and it was difficult to get maintenance men to service the filters. In recent years this situation has been improved by the use of oil circulating systems to flush the dirt from the filter tank, cleaning and conditioning the oil in a settling tank or oil filter. Due to the abrasive nature of much of the dirt removed from the oil, activated earth type cartridge filters have been preferred in most installations.

Best overall operation of the filters is obtained by a continuous oil circulating and conditioning system. See Figure 13. This keeps clean oil in the filter tank at all times and results in most efficient filter operation. Some of the most successful installations of this type use a settling tank to remove heavy dirt from the oil, followed by an activated earth type cartridge filter to remove fine dirt and moisture. The settling tank is arranged so that accumulated sludge is periodically flushed directly into the sewer system. This system gives the advantages of thorough oil conditioning by the cartridge filter units, with the settling tank carrying the heavy dirt load and greatly extending the life of the filter cartridges. The

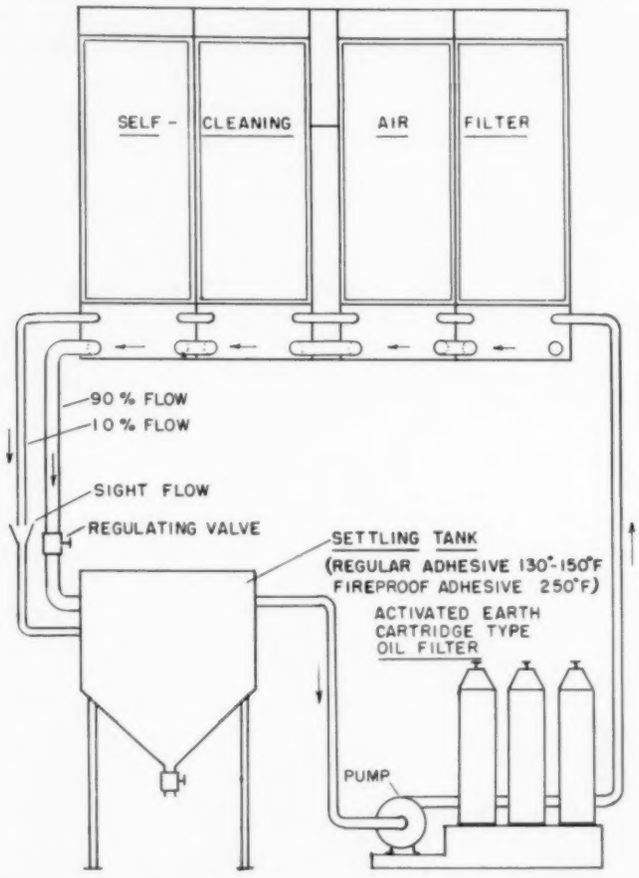


Figure 13 — Sludge removal and adhesive cleaning system for self-cleaning air filters.

temperature of the settling tank should be maintained at 130 to 150 F for regular adhesives and at about 250 F for fireproof adhesives to accelerate settlement of the dirt. Soil heating cable has been used to advantage to heat the oil in the filter tank and in the drain line. This greatly improves cold weather operation and helps prevent freezing of any moisture present.

The use of an oil cleaning system permits most of the filter servicing to be done at the oil conditioning equipment rather than at the filter itself. This is particularly advantageous if the filter is located on the roof or in other relatively inaccessible locations.

ELECTROSTATIC TYPE AIR FILTERS

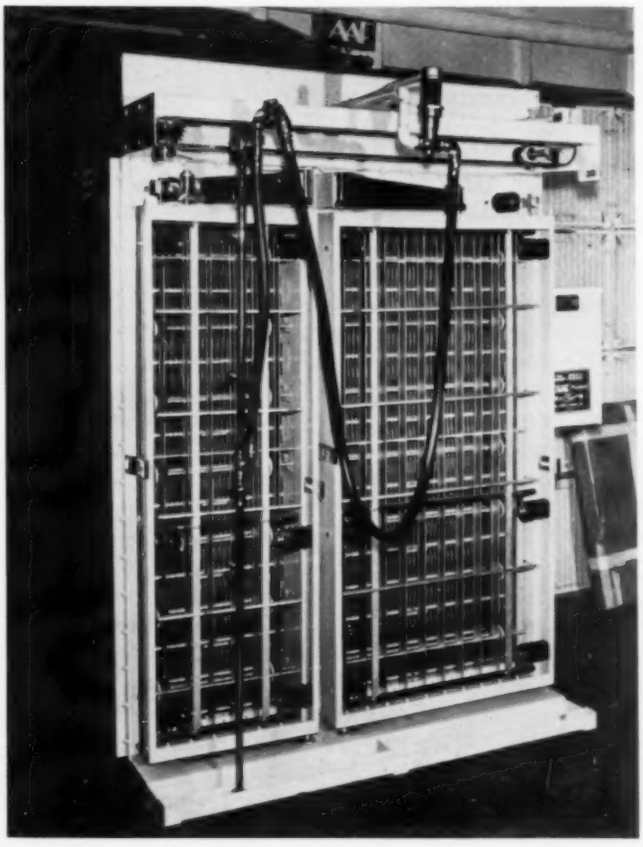
Electrostatic precipitation type filters remove dust by creating an electrical charge on the dust particles

and then attracting them to an oppositely charged plate. This plate is coated with an adhesive to catch and hold the dust particles. In some recent installations, as noted before, the adhesive is omitted, in which case the precipitation filter acts as an agglomerator, holding the particles only until they attach themselves to other particles and blow off in particle sizes which can be handled by an impingement filter in series with the electrostatic filter.

Electrostatic type air filters are particularly effective in removing fine air-borne solids, such as soot. Heavy dirt particles may pass through the filter if their inertia is sufficient to overcome the electrostatic attraction of the coated plates. Electrostatic units are, therefore, best applied where the major part of the dirt is of small particle size, and should be backed up by an impingement type unit for extremely heavy dirt concentrations, or where best overall cleaning efficiency is required.

Although some of the electrostatic type filters are of the traveling screen type as described above, most of the units on the market are cleaned by washing down with hot water, followed by a drying cycle, and then a recoiling cycle. The washing and recoiling may be done manually or the filters may be furnished with an automatic washer. For steel mill applications it is recommended that a washer be purchased to cut down maintenance time and to help insure that maintenance is carried out. Basically, these washers consist of a series of nozzles mounted on a head which travels across the face of the filter during the washing cycle. On completion of the washing cycle, oil is pumped through the same nozzles to apply a coating of adhesive on the filter precipitation plates. A typical filter with washer is shown in Figure 14.

Figure 14 — Electrostatic type air filter shown has automatic washer.



The washing cycle on automatic washer type electrostatic filters must be initiated by the operator, but on most units is automatic from that point. A washing cycle of about 5 minutes is followed by a period of 20 to 25 minutes drainage and drying time followed by the oil spraying cycle.

The overall problem of filter maintenance can be improved if the filter can be serviced during normal mill operation rather than trying to take care of the servicing during shutdown periods when something else has to be done and the dirty job on the air filter is omitted. Electrostatic units normally do no filtering with the power off and it is therefore desirable to sectionalize the installation so one part can be shut down for washing and servicing while carrying plant load on the remainder of the units.

Regular maintenance on electrostatic units is necessary for satisfactory operation. This is highlighted in a letter recently received from one of the manufacturers of electrostatic air cleaning equipment. He makes the following points:

1. To keep the unit in good operating condition, it is essential that it be washed at regular intervals — preferably not more than a two weeks cycle. The adhesive coating is absorbed by the accumulated dirt, and the dirt and adhesive tend to harden when left on the plates for a period longer than three to six weeks. It is then difficult to remove the residue by any ordinary washing means.
2. It is essential that wash water be supplied at the specified temperature and pressure and in adequate quantities. (Approximately 15 gal, 140 to 160 F water, 40 to 75 psi pressure per 1000 cfm filter capacity per washing cycle.)
3. Sufficient adhesive should be used regularly as this not only helps hold the dirt but assists in the removal of the residue by keeping it soluble. (Approximately 0.2 gal per 1000 cfm filter capacity.)
4. About 90 per cent of the washing problems arise from the lack of observing one or more of the above points. Trouble has been experienced with washing where cold water has been used instead of hot water as specified. In other cases brackish water has been used, which has resulted in plugging up the washer nozzles and leaving a very hard coating on the surface of the plates, which causes the unit to be entirely inoperative. Dirty water should never be used and will not serve the purpose.

The removal of tarry deposits may be helped by the use of a detergent in the wash water. A neutral detergent should always be used since most electrostatic filters contain aluminum parts which are severely attacked by alkaline detergents.

Some manual servicing of the filters is required periodically to remove dirt deposits from insulators and other spots where the water sprays may not reach and to replace any ionizer wires which may be broken.

FANS

Centrifugal fans are normally used in steel mill applications. Axial flow fans may be advantageous where space is at a premium or where the fans can best be installed in an air duct. The efficiency, noise level and weight are about equal for the two types. A centrifugal

fan is generally easier to maintain as bearings are more accessible.

Fans for steel mill duty should preferably have a non-overloading horsepower characteristic to prevent overloading of the fan motor under any possible variation in operating conditions. A drooping characteristic in the curve of air volume versus pressure is desirable to insure that the actual volume of air circulated does not vary too widely from design conditions.

Fans operated in parallel should be equipped with back draft dampers. This avoids windmilling of a fan shut down for inspection and may, under some conditions, permit carrying partial load with one fan down.

There is very little maintenance required on fans beyond periodic inspection of bearings. Maintenance of V-belt drives may be reduced considerably by specifying a V-belt drive rated at double the horsepower of the fan motor.

SURFACE AIR COOLERS FOR RECIRCULATING SYSTEMS

Air coolers should be standard heavy-duty industrial-type finned-tube units. Water is circulated through the tubes with the air passing transversely over the tubes. Removable cover plates or water boxes should be provided at both ends so the inside of the tubes may be cleaned periodically.

Regulation of water flow through the air coolers, either manually or automatically, permits retention of any desired part of the electrical losses in the system. In winter, all the loss may be retained for heating by shutting off the water supply. In summer, full water flow may maintain motor room temperatures within 10 F of water supply temperature.

The cooling water requirements will vary from approximately 0.8 gpm per kw loss for a 10 degree F temperature differential between incoming water and cool air to approximately 0.5 gpm per kw loss for a 25 F differential. The water can be used in the mill after passing through the air coolers. The water temperature rise will be approximately 8.5 F for the 0.8 gpm per kw usage.

A bypass line should be provided so any excess of mill water requirements over that for the air coolers may be met. This is particularly important for winter operation when it may be desirable to cut off part of the water to the coolers to maintain motor room temperature.

The surface air coolers in recirculating systems should be inspected at regular intervals and cleaned, if necessary. The inside of the tubes are subject to fouling from the cooling water and should be cleaned in the same manner as the steam condensers in a power station. Any accumulation of mud, slime or scale on the inside of the cooler tubes acts as a heat insulator and greatly impairs the efficiency of cooler operation. There is no advantage in using large tubes insofar as these factors are concerned, since the coolers would fail to operate properly long before the thickness of deposit on the inside of the tubes reached the point of tube plugging.

Mud deposits in the cooler tubes may frequently be removed by inducing turbulence in the cooler. In some cases this can be done by introducing compressed air into the inlet water line, but it should be pointed out that air must not be admitted continuously since entrained air in the water will result in excessive erosion of the tubes. Soft deposits can be removed from the tubes by forcing rubber plugs through the tubes with compressed air, or by brushing. Hard scale deposits must be removed by a scraper type cleaning plug. Frequency of cleaning the inside of the cooler tubes must be established on a local basis and cannot be determined on the basis of water analysis. It is suggested that the condition of the inside of the cooler tubes be checked at the beginning of the hot weather season.

The outer fin surfaces of the tubes should be inspected regularly for dirt accumulation and cleaned if fouled. This may be done by blowing out the dirt with compressed air or may require water or steam cleaning. In any case, the first cleaning should be done with the cleaning fluid flowing opposite to the normal direction of air flow, followed by a cleaning cycle with the cleaning fluid flowing in the same direction as normal air flow. Caked deposits resulting from carbon dust or other dirt mixed with oil vapor may require the use of a detergent solution or a noninflammable type solvent.

GENERAL SYSTEM MAINTENANCE

As has already been pointed out, regular maintenance is required on air filters, fans, and air coolers. In addition, regular inspection should be made to see that other parts of the system are in proper operating condition. This includes checking of air ducts to see that there are no large openings through which air escapes, that access openings are closed, and that machine ventilating covers are in place. While it is recognized that many motor-generator sets and motors will operate without ventilating covers, such operation is definitely not in the interest of ventilating system efficiency. Reversing motors and special low-inertia design motors will not operate without forced ventilation and under no condition should such motors be operated without their ventilating covers.

RELATIVE COSTS OF TYPE OF VENTILATING SYSTEMS

A general comparison of the overall cost of various types of ventilating systems is given by Figure 15. These curves include only the cost of the necessary air filters, fans and coolers and do not include ductwork, piping or installation costs.

Extra study on the overall layout of the equipment can frequently result in much simpler and much lower cost air ductwork, water piping and overall installation costs. In most cases the ductwork can be simplified enough so that there should not be too much difference in the installed cost of the ductwork for a recirculating system as compared to a non-recirculating system. Additional water piping is, of course, required for a recirculating system.

The relatively high cost of a recirculating ventilation system using an air washer for makeup air in areas where freezing temperatures occur is due to the necessity of making the washer oversize in order to permit sufficient recirculation in cold weather to prevent freezing.

A cleaning system for facilitating sludge removal from a self-cleaning type air filter will add from 10 to 25 per cent to the cost of the system, depending on the type

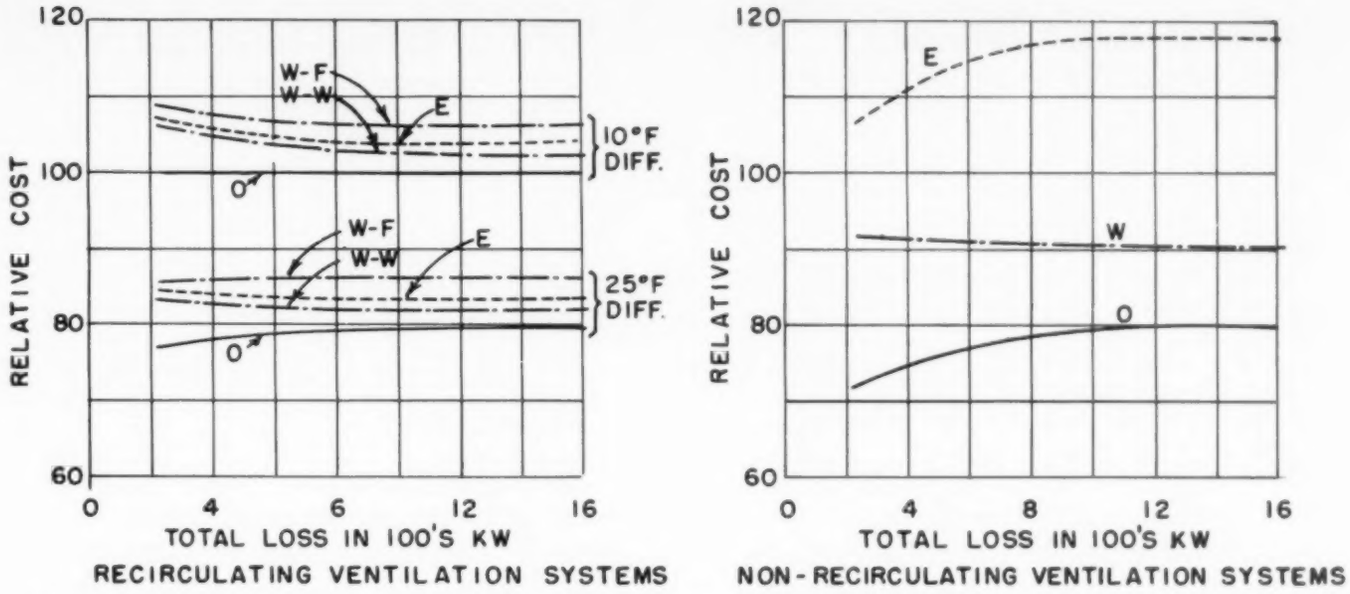


Figure 15—Relative cost of ventilation systems. All relative costs are based on recirculating system with oil film air filter and coolers for 10 F differential temperature water to air. Cost includes air filters, fans and coolers, but no ductwork, piping or installation.

Curve designations:

O — traveling screen type, self cleaning, oil film air filter.

E — electrical precipitation type air filter.

W — air washer.

W — W washer installed where freezing temperatures do not occur.

W — F washer installed where freezing temperatures may occur.

10 or 25 F diff — temperature difference between cool water and cool air used for air cooler design.

and completeness of the oil cleaning equipment installed, and on the size of the system.

SUMMARY

Maintenance still seems to be the most difficult problem in the ventilation of electrical equipment. A properly installed filter will take the dirt out of the air only as long as the dirt is taken out of the filter. There are some very well maintained and efficiently operating installations. At the other end of the scale are installations which have been severely neglected. Installations have been seen where the filter was so plugged with dirt that the doors at the ends of the filter room were blocked open to bypass enough air to cool the machines. Another case on record is that of an installation with roughing and finishing filters in series that operated for over a year before adhesive oil was put into the filter tanks.

In one installation an air washer was fitted with flow proportioning control for recirculation, heating coils, and an alarm system to prevent freezing. A service call after the first cold snap found the air washer frozen solid. The 110-volt supply to the control system had not been connected.

Admittedly, these are the horrible examples of "how not to ventilate," but too many installations are operating toward this end of the scale instead of being properly serviced and cleaned — and the filter manufacturer and the ventilation system design is frequently blamed for the poor operation. Regardless of how carefully your system may be designed or what type of equipment you have, its operation will be no better than the maintenance given it. In setting up the maintenance schedule for your ventilating system, please do not fail to take into account that its function is to help protect your production as well as your mill, its drive equipment and its control system. Maintenance of the ventilation system is protective maintenance on overall mill operation. Maintenance of the ventilating system today may prevent a costly shutdown tomorrow.

BIBLIOGRAPHY

1. "*Air Filters in Rotating Electrical Equipment*," by F. C. Reutenauer, 1953 AISE Proceedings, p 773.

2. "*Air Cleaning for Motor Rooms*," by T. O. Zittel, 1952 AISE Proceedings, p 31.

3. "*Air Filter Oils — Reconditioning*," by George Findlay, 1952 AISE Proceedings, p 610.

4. "*Ventilation of Steel Mill Motors and Motor Rooms*," by S. L. Jameson, 1951 AISE Proceedings, p 22.

DISCUSSION

PRESENTED BY

W. Y. HUMPHREYS, Application Engineer, Sturtevant Div., Westinghouse Electric Corp., Pittsburgh, Pa.

B. A. SHRIVE, Superintendent, Electrical Maintenance, Kaiser Steel Corp., Fontana, Calif.

S. L. JAMESON, Construction Engineering Section, General Electric Co., Schenectady, N. Y.

W. Y. Humphreys: The writer's emphasis on the importance of a coordinated, well designed, and properly maintained ventilating system is good advice. It is

well to remember that it is considerably cheaper, maintenance-wise to remove collected dirt from an air filter than to remove it from the electrical equipment being ventilated.

We note that mention is made of the use of air washers as a means of cleaning the makeup air for motor ventilation systems. As noted, the cleaning efficiency of an air washer is very poor while the cost is relatively high and the disadvantages are many. Under these circumstances it might be questionable whether the use of air washers to clean outside makeup air can be justified.

It has been pointed out, however, that a certain amount of humidity in a motor room is good for commutation. For humidification only, an air washer will do a good job and there are mills where they are being used on recirculating air simply to add humidity in winter months where the tendency of the motor room is to be very dry. On this application, the air washer would be installed simply to take motor room air through the washer and discharge it back into the motor room. Humidity control then becomes basically a manual procedure handled by the motor room attendant who turns the sprays on or off as minimum humidity requirements dictate.

The paper also mentions the possibility of using an electrostatic filter in front of an impingement type filter, and operating the electrostatic unit without adhesive to result in a theoretically maintenance free system. We wonder whether this arrangement has actually been attempted in the steel industry. In steel mill localities it has been found that the dirt collected from an electrostatic unit can amount to six times the volume of dirt collected by a standard impingement unit alone. This is a volume measurement rather than a weight measurement, but it would indicate the rate at which an impingement would load up and require replacement or servicing. If all the dirt that is collected by the electrostatic unit is ultimately collected in the impingement filter, it would seem that the rate of replacement of the filter media could be as much as six times the normal rate and the maintenance cost as a consequence would be very high.

B. A. Shrive: Mr. Jameson has covered this subject of ventilation so thoroughly from every angle that there is little left to be said. He did mention the problem that many of us have regarding the maintenance of air conditioning equipment, and with this in mind, I would like to make a plea to all designing engineers to give the maintenance problems much more thought when they are laying out and designing ventilating equipment.

The type of filter used and the location of heat exchanges in respect to our maintenance certainly should be given more consideration, so that a better job of maintenance can be done in the short time available for this service.

S. L. Jameson: We agree with Mr. Humphreys in that other types of air cleaning equipment are more efficient than an air washer. We feel that the principal application for air washers is in those installations where additional humidity is required and where most of the dirt particles are of a relatively large size. Washers are also preferred by some operating personnel for maintenance reasons.

An electrostatic unit has been operated without adhesive ahead of an impingement type filter in some installations in order to transfer most of the maintenance to one unit, and, at the same time, maintain the greater efficiency of the combined electrostatic filter-impingement filter installation. It does increase the maintenance on the impingement unit but with the continuous roll type of impingement unit, the feeling has been that total maintenance is less and easier to achieve. No such installations are in service in steel mills at the present time, but one installation is now being made using an existing electrostatic unit with a new continuous roll type impingement unit behind it. The electrostatic unit will be steam cleaned to remove all adhesive as soon as the impingement unit is ready to go into service.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill,"

published by the Association of Iron and Steel Engineers.

If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Modern Coal Mining—Underground

. . . . the coal industry is not lagging in efforts to modernize coal mining and to extract coal more economically and more safely . . . . outstanding developments are the multiple-purpose mining machines for the extraction of coal and the use of bolts or pins anchored in the roof strata for supporting roofs . . . . many other refinements are also being continuously developed . . . .

By R. H. KNAPP
Chief Engineer — Coal
Central Operations
United States Steel Corp.
Pittsburgh, Pa.

▲ IN presenting to a group primarily concerned with the many phases of the iron and steel producing industry a report on modern underground coal mining, those features in mining which highlight the common interests of both industries should properly be set forth.

Coal is one of the essential raw materials of the iron and steel industry. Likewise, it is still the largest source of fuel for the production of electrical energy, which is used to power the machinery of the steel mills. But in addition to these points of mutual interest, the coal mining industry is a substantial consumer of steel and steel products. Application of modern methods and practices has made coal mining today a greater consumer of the products of the steel industry than ever before.

In an effort to overcome mounting production costs and to maintain a competitive position despite decreasing markets and other unfavorable economic factors, the coal mining industry has sought to improve efficiency through employment of machines on an increasing scale to perform the operations that are necessary in the recovery of coal. Development of improved machinery for strip mining has advanced concurrently with the expansion of the use of mechanical mining methods underground. Notable developments in strip mining include the use of larger equipment in order that coal with higher overburden ratios can be economically recovered, and the application of auger mining to increase the recovery of coal from a strip operation after the economic limit of overburden depth has been reached.

Strip mining has its own characteristic features and distinct problems, many of which have no counterpart in underground mining, and therefore the former class of mining is not within the scope of this presentation.

Progress in the application of machinery to perform many of the functions entailed in the underground mining of coal was retarded by the depression years between 1930 and 1940. During World War II, and in the years since, first, to meet the heavy demands for increased coal production, and later, to offset in some degree the sharp upturn in production costs, mechanization of mines and adoption of improved methods have progressed at a greatly accelerated rate. Today, the extent of modernization and mechanization of many of the underground coal mines compares favorably with that of other industries that are noted for their progressive policies.

In 1952 the United States produced 505,000,000 tons of coal of all kinds. Included in this total are 465,000,000 tons of bituminous coal including lignite, and 40,000,000 tons of anthracite. Of the total bituminous and lignite output 362,000,000 tons were produced in underground mining operations. Approximately 76 per cent of bituminous coal produced by underground mines was mechanically loaded. It should be noted with respect to the latter figure that coal hand-loaded onto conveyors is classified as mechanically loaded, and approximately 12 per cent of the coal reported as mechanically loaded falls into this class.

Modern underground coal mining is characterized by healthy progress in wider and more efficient use of machines and modern materials. Continually beset by problems presented by both Mother Nature and the exigencies of existing in an industrial economy, the coal mining industry is seeking the best possible solutions to such problems through the judicious employment of manpower, together with the equipment, materials and practices described in the following paragraphs.

FACE PREPARATION

1. *Cutting* — Before the coal can be loaded it must be broken from the solid seam at the face. Modern con-

ventional coal cutting machines are single-purpose machines that cut coal as required by the conditions and practices prevailing at the point of their use. The cutting operation is usually found to be the limiting control on the production which can be obtained from a given section of a mine. The number of cuts, thickness of seam, width of working place, hardness of coal, presence of slate partings and other intrusions in the coal influence the rate of cutting and determine the amount of coal that can be prepared for loading at each trip the machine makes into the working place. Bits used in modern coal cutting machines may be of alloy steel, hard-faced, or tungsten carbide-tipped, depending upon the cutting conditions. Today cutting machines are track-mounted, equipped with pneumatic tires, or crawler-mounted to suit the system in which they are used. Where mining conditions are favorable to the use of the trackless type equipment, substantial reduction in costs has been realized with the replacement of track-type equipment by trackless methods.

2. *Drilling* — Holes are drilled into the coal face for the purpose of receiving the blasting charge. The drilling, either before or after the cutting, is accomplished in one of a number of ways in mechanized mining. Hand-held power drills, post drills, electric or hydraulic drills mounted on frame of cutting machine, or self-propelled mounted drills are all available for selection to fit best the needs of the mining practices in use. A recent addition to the drilling equipment is the hand-held lightweight hydraulic drill usually connected into and driven from the hydraulic system of the cutting machine.

3. *Blasting* — Modern mining practices employ one of two different agents for dislodging the coal under conventional mining methods. The most widely used is the permissible explosive. Instead of the explosive the coal can be broken by high pressure compressed air piped into the working places from a centrally located compressor station. Under most conditions less fine coal is produced with the use of compressed air, and this feature has gained added importance with the growth in the practice of cleaning coal by mechanical means. Increased proportions of fine sizes mean greater investment in preparation facilities and higher expense for drying the coal before shipment. Nevertheless, economies to be gained by reducing the amount of fine coal in the coal going through preparation facilities must be weighed against the higher cost of the face preparation with compressed air.

LOADING

The loading machine is moved into the working place after the coal has been broken from the face. Like the cutting machine this is a single-purpose unit and the type of mounting is suited to the system in use. It also offers the three types of mounting; track type, crawler type, and, in the case of at least one make, rubber-tired. The loading machine is a high capacity unit, attaining rates up to ten tons of coal per minute. Accordingly, the face preparation steps must be sustained at a high level of efficiency in order to keep as much loose coal in front of the loading machine as is consistent with the limitations of the related transportation system.

CONTINUOUS MINING

The single-purpose machine performs essentially a single function of mining at the working face. Then it must be withdrawn to be succeeded by other units of the production set-up for the purpose of carrying out succeeding functions. In order that all units may be working at full efficiency, it is necessary that additional working places be provided near at hand. The single-purpose units then enter the places in rotation and carry out their respective functions without interference. The addition of extra working places to afford an opportunity for continuous performance of the functions of mining coal by the single-purpose units spreads the active working area, introducing delays in moving from place to place and increasing the extent of open ground that must be maintained.

The development of the multiple-purpose machine had as its objectives the elimination of the delays of moving from place to place of the single-purpose units and the concentration of mining activities to the minimum number of places consistent with sound ventilation practices, proper roof control, and the characteristics of mine projection. One of these machines which was introduced to the coal industry first in 1947 was given the name "continuous miner." The result has been that the term "continuous mining" has been widely adopted to describe the system of mining wherein any multiple-purpose mining machine is used as contrasted with that where single-purpose units are used.

Today there are a number of different types of multiple-purpose machines in use, while at the same time others are undergoing development. The multiple-purpose or "continuous mining" machine combines in a single unit the actions of dislodging the coal from the solid seam and loading it into some unit of a transportation system. Thus, it replaces the separate steps of cutting, drilling, blasting and loading of the modern conventional track or trackless mechanical mining method.

Many multiple-purpose machines have now been delivered to mines in the United States. At some mines the total output comes from such machines. The continuous mining machine has proved to be a highly significant factor in the coal industry's search for ways to reduce the cost of producing coal. Its use has brought with it attendant problems of face transportation, ventilation, dust control and roof support. Mining projections suitable for a mining system with conventional equipment are not applicable in most cases to a continuous mining system. Problems of machine maintenance are increased. Final solutions to these problems have not been attained as yet for the possible range of conditions that exist in coal mining. An alert and aggressive mining industry seeking to gain the utmost from the opportunity for cost reduction through use of the continuous mining system will reach practical solutions to each of these problems in due time. The acceptance of the multiple-purpose machine as a production tool in those conditions where it is found applicable by the American mining industry is an outstanding advance in modernization of the industry. Its importance is only overshadowed by the adoption of roof bolting for support of the roof in coal mines. These two achievements show that the coal mining industry is alert and willing to

adopt new and improved methods and equipment as they become available, provided that their adoption is economically sound.

TRANSPORTATION

Highlights in modernization of coal mine transportation systems include installations of larger capacity mine cars; automatic couplings; drop bottom mine cars; heavier locomotives for longer trains; and heavier rails. Fixed belt conveyors are finding wider use in underground transportation systems for main haulage service, and particularly for hoisting up slopes in preference to a vertical shaft with cage or skip hoisting.

Introduction of the rubber tire-mounted shuttle car near the end of the 1930's brought with it the concept of trackless mining as now applied with the conventional single-purpose mining machines. A logical outcome of its appearance was the development of the trackless cutting machine, the trackless loading unit having preceded the development of the shuttle car. More recently a crawler-type shuttle car has been produced and found to have certain advantages over the rubber-tire car where the mine floor is soft and wet.

Portable conveyors operating in face areas and serving to bring coal from the working panels to the main line haulage system have found wider use in the past in the mining of the thinner seams of coal than in those seams where ample height is available for use of mine cars or trackless shuttle cars. However, this situation appears likely to change following the advent of the multiple-purpose mining machine.

A major problem in the application of the multiple-purpose mining machine is the lack of a face transportation system with the degree of continuity of operation which will afford the realization of an operating output nearer the high potential capacity of the unit than is possible with transportation systems in general use up to the present time.

In initial applications of the multiple-purpose mining machine, shuttle cars were selected for the transportation medium. In an endeavor to keep the machine operating throughout as high a proportion of the available working time as possible, an arrangement has been employed in which a shuttle car has served as a surge bin immediately behind the mining machine while one or more shuttle cars traveled between the surge car and the main line transportation facility, receiving its load from the surge car and discharging it into mine cars or onto a conveyor.

Attempts to solve the face transportation problem have brought forth short length mobile conveyor units to follow and serve immediately behind the mining machine. Other efforts are being directed toward development of a large capacity surge car.

Final resolution of a satisfactory face transportation system to serve with multiple-purpose mining machines undoubtedly will result in more extensive use of the portable mine conveyor. The ultimate system may involve conveyors alone or a combination of shuttle cars with conveyors, wherein the conveyors will be used to shorten the shuttle car haul distances and thereby increase the capacity of the system. In this connection both belt and chain flight conveyors will likely be utilized either separately or in combination.

Adequate face transportation is a major problem to only those multiple-purpose machines with high potential loading capacity. In one type of machine, requisite functions in dislodging the coal are performed during the period the shuttle car is away from the machine transporting the coal to the unloading point. On return of the shuttle the machine resumes loading, but is able to do so at a higher rate as a result of the work done during absence of the shuttle car. The shift output of the machine is substantially equal to the capacity of the shuttle car transportation system provided haul distances are not permitted to become unduly long. In the case of another type of multiple-purpose machine, the coal planer, a conveyor is an integral part of the machine itself, and portable mine conveyors can be readily placed to receive coal discharged from the machine conveyor. The operation of this machine is such that its output need not be penalized by the necessity of having to move the portable conveyors serving it.

ROOF SUPPORT

Support of roof strata in mine excavations by means of roof bolting was practiced in the lead-zinc mines of the tri-state area as long ago as twenty-five years. Yet it is only within the last six years that it has been adopted for general use in underground coal mines. Nevertheless, its adoption has been one of the most important and promising advances in the coal mining industry in many years.

Essentially, roof bolting consists of anchoring bolts in the roof strata overlying a mine opening and providing a bearing plate at the lower end of the bolt. The key to successful roof bolting is proper anchorage for the bolt within the rock strata. The length of bolt to be used therefore is to some extent determined by the distance to suitable stratum for anchorage above the coal seam. The great majority of all roof bolts used in coal mines is in the range of four to six feet in length. Steel is almost universally used for bolt material. However, wooden pins have been used in some instances for roof bolts and have proved successful in application.

Bolts are usually placed vertically, although those along the sides of entries may be angled toward the solid coal so that the anchor point will extend into strata directly supported by the unmined coal. Two methods of anchoring bolts are in general use. In one the end of the bolt is slotted to receive a wedge, and anchoring is accomplished by forcing the wedge into the slot through upward pressure on the bolt with the wedge against the back of the hole. The lower end of the bolt is threaded to receive a nut. With the bearing plate in place over the bolt the nut is run up tightly against the plate.

The second type of anchor consists of a threaded expansion shield which is spread apart by the tightening of the bolt to grip the sides of the hole. With this type of anchor a headed bolt can be used. Chief advantages of the expansion shield over the slot and wedge anchor are the absence of need for drilling the holes to close depth measurement to assure that the bolt can be effectively anchored, and the limiting of the extent of bolt projection below the bearing plate to the depth of the bolt head. The only requisite is that the hole be slightly greater in depth than the length of bolt extending into the hole above the line of the roof. Both types provide firm, effective anchorages when properly used.

Need for proper anchorage has been mentioned. Failures of roof bolts to support the strata will occur when a competent band of material in which to anchor the bolts is lacking, and proper tension of the bolts cannot be maintained. Also, if the immediate roof strata has a tendency to crumble away from around the bolts, this method of roof support cannot be successfully used. In some instances roof bolts may still be used effectively if steel channels are used to span the width of the entry and are held tight against the roof surface by two or more bolts in place of the individual bearing plates held in place by single bolts. The spanning of the distance between individual bolts by channels keeps the immediate roof material, which would otherwise crumble, in place and thus prevents loss of tension in the bolts. Action of bolts in supporting roof strata over mine openings is twofold. First, and probably more important in a great majority of the cases, the bolts suspend the immediate roof material from a strong, competent overlying stratum of rock. In this case the effect is to have the dead weight of the immediate roof material supported by the bolts in tension. The second action is that of binding a series of bands of rock together so that they serve as a composite beam over the span of the opening instead of behaving separately as beams of relatively much lesser depth and thus more readily subject to failure.

Drilling of holes for roof bolts is done in the modern coal mine with air-operated percussion type drills for the most part. In some instances where the roof materials to be drilled consist of shales or interbedded bands of coal and shale, drilling can be done with rotary drills employing auger type bits. The drilling of roof bolt holes has brought with it the attendant problem of dust suppression. Since the drilling is overhead and therefore use of wet type drills creates unpleasant working conditions for the drillers, efficient vacuum type dust collectors have been developed and made available for use with the drilling equipment. Portable and semi-portable air compressors are used to furnish air for operating the drills and the impact wrenches used in tightening the bolts. Commonly used diameters for roof bolts are one inch for slot and wedge type bolts and three-quarters of an inch for bolts anchored with expansion shields.

Early in the use of bolts for support of roof in coal mines it was thought that primarily roof bolting would be limited to haulage and ventilation entries which would have long lives and therefore the higher cost of roof bolting over conventional timbering for the initial installation could be justified. With the improvement in technique and development of efficient, modern tools for installation of bolts, and with the growth of knowledge of the characteristics of roof bolting gained from experience with this method of roof support, its use in the development of rooms and the extraction of pillars is expanding rapidly. At some mines roof bolts alone may be used, and at others roof bolts in conjunction with conventional wooden timbering are used. When all factors are taken into consideration, including the storage outside and subsequent handling from storage to point of use in the mine, the cost of materials, the cost of labor for installation, the better roof support provided, and the rapid gain in proficiency of mine personnel in placing bolts, the cost of roof bolting does not far exceed the cost of supporting mine roof with the conventional wooden timber supports, and in some cases undoubtedly is equal to or even less than the latter method.

A number of advantages which roof bolting possesses over use of timber supports are worthy of note. Clearance height for movement of equipment is increased. Roadways are unobstructed by timber props. Places can be driven narrower to gain added control of the mine roof. Mine personnel are free of the necessity for guarding against the dislodgement of supports during movement of equipment, and the hazard of sudden roof falls which may occur as a consequence of such dislodgement. Air courses are free of posts that increase friction losses. Effectiveness of bolts in supporting the roof insures that air courses will not be partially or wholly blocked by falls after standing for some time. Need for replacing timbers in those sections which last beyond the normal life of untreated wooden props is removed. Opportunity is presented for operating cost saving in handling supplies.

Roof bolting has proved to be a reliable method for handling one of the biggest and most troublesome tasks in mining, the provision of adequate and safe support for the mine roof, and has caught the imagination of the coal mining industry at a rate few, if any, other innovations in the industry have ever equalled. It is in step with the modern methods and the utilization of modern materials, in this case steel, which are characteristics of the present times.

The significance of coal mine roof bolting to the iron and steel industry can be illustrated by a rough example of the market potentialities for steel products which exist in this phase of coal mining operations in the United States.

Conditions

a. Bolt spacing: 4 ft-0 in. × 4 ft-0 in. centers.
b. Average bolt size: ¾ in. diam × 5 ft-0 in.
c. Average bearing plate size: ⅜ × 6 × 6 in.
d. Thickness of coal seam: 60 in.
e. Annual production of bituminous coal and lignite from underground mines in 1952: 362,000,000 tons.

If it is assumed that bolting for roof support is limited to mine development alone, which accounts for approximately 25 per cent of the mine output, the potential market for steel in only the materials required for roof bolting in bituminous mines at the annual rate of production in 1952 is about 175,000 tons a year. Additional quantity of steel and steel products will be required for the machinery, tools, and supplies utilized in the installation of roof bolts. An additional feature of this use for steel is the fact that it is largely taking the place of wood in mine roof supports. It is true that to some extent it is also replacing steel structural sections used underground for roof support, but the greater displacement will be in wood timbers. With the increasing scarcity of sources of timber near the mines, it can be anticipated that the use of bolting for roof support will expand substantially in the years ahead.

PRACTICES

Development and trial of other mining systems characterize modern underground coal mining. The introduction of multiple-purpose mining machines has brought with it patterns of mine development and

extraction of pillars that are adapted to securing the economic benefits of production concentration that such machines render possible. The longwall system of mining which has been used to great extent in European countries for many years, but was little used in this country in the past, is now undergoing investigation and trial in thinner coal seams in conjunction with utilization of the coal planers and coal strippers which were developed and are built in Europe.

Other examples of endeavors of the coal mining industry to keep abreast of technological progress and to employ those practices that will afford the means of combatting rising production costs are to be found among the following list of modern methods, mechanical equipment, and materials in wide use in underground mines today:

a. Contour mining where seams outcrop over wide areas.
b. Mantrip cars to transport men to and from working stations underground.
c. Trolley phone systems for dispatching and communication.
d. Mercury arc rectifiers and selenium rectifiers for power conversion.
e. Plastic pipe for use with corrosive mine water.
f. Axial flow mine fans.
g. Stainless and alloy steel products for light weight, strength and corrosion resistance.
h. Tungsten carbide-tipped cutter and drill bits.

Depletion of higher quality coal reserves, competition from other fuels, and customer demands for higher standards in coal quality have caused the construction of numerous mechanical coal cleaning plants throughout the industry. Many new plants are undergoing construction today. Notable improvements in coal cleaning practices in recent years include the use of heavy media separation, the centrifugal filter for dewatering fine material, and the expansion of the cleaning of fine sizes by tabling. Older methods of washing have been improved by adoption of advanced techniques and modern equipment. The use of heat drying to reduce moisture content of washed coal is becoming an item of increasing importance in the consideration of preparation plant design.

SUMMARY

Review of the elements which characterize modern underground coal mining discloses that two outstanding developments in the industry within the past six years are the adoption of the multiple-purpose mining machine or "continuous miner" as a production unit by the industry, and the introduction to coal mining of the method of supporting the roof in mine openings by use of bolts or pins anchored in the roof strata. These two innovations, together with the improved methods and mining equipment resulting as a direct consequence of this adoption, as well as numerous other improvements in methods, materials and equipment, are evidence of the acceptance by the industry of the necessity for modernization. It can be concluded that the coal industry is not dragging its feet in accepting new ideas and new and improved machinery; and that the necessity for keeping down the cost of producing coal puts tremendous pressure on the industry to seek further ways for cost reduction through modernization. The result will be that in the ensuing years even greater attention will be given to the application of the most advanced techniques, and to the expansion of the use of modern equipment and modern materials.

Despite the fact that the expansion of trackless mining has displaced in the past and will continue to displace steel rail from the producing zones of the mines, this shrinkage in the requirements for steel is far outweighed by the increase in steel requirements resulting from the use of heavier rails in main line haulage, demand for roof bolting materials, expansion in use of mechanical equipment, and construction of mechanical cleaning plants.

AISE
WEST COAST MEETING

Hotel Statler
Los Angeles, California

February 20, 21, 22, 1956

Make Your Reservations Early

GEAR TYPE COUPLINGS GIVE TROUBLE-FREE SERVICE

▲ MORE than 10,000 hours of trouble-free performance by two gear type spindle roll drive couplings at the 80-in. hot strip mill of United States Steel Corp.'s Irvin Works are showing the way to the solution of a traditional mill maintenance problem. The mill, one of the largest of its kind in the country, has an average production of better than 2700 tons per eight-hour turn.

The gear type couplings, produced by American Flexible Coupling Co., Erie, Pa., serve pinch roll drives of the hot mill's coiler machinery. Utilizing specially patented gear teeth with fully crowned flanks at either end of the spindle shaft, the gear type couplings eliminate the need for brass slippers and costly machine maintenance identified with universal or slipper-type couplings.

The Amerigear spindle drive couplings serve the lower rolls of two of the coilers. Each of the couplings — with a 7⅛-in. shaft diameter, a 10⅜-in. hub diameter and a 13⅝-in. flange — operates at three degrees misalinement.

The first coupling was installed in April 1954; the second one a year later. During their period of operation in the coilers, the couplings have needed no maintenance attention other than periodic greasing.

Four conventional universal couplings installed in the same coiler assembly have required customary routine maintenance at the end of an 18-turn week. The weekly maintenance of each universal coupling involves the replacement of four brass slippers — two at either end of the spindle shaft. Expenses associated with the operation include: cost of material plus an average time expenditure of three hours for machining each slipper.

During 1953, when universal couplings were used exclusively in the pinch roll drive machinery, 483 brass slippers were replaced according to records maintained at the Irvin Works.

Nor does the weekly maintenance expense of replacing slippers reflect the total savings achieved through the use of the gear type couplings. Additional costs incidental to the use of universal or slipper-type spindle drive couplings include the rewelding and machining of the spindle tongue every two weeks, and similar machining of the slipper seat every three months.

Maintenance of the spindle tongues requires approximately eight hours per spindle, while the machining of slipper seats involves a time expenditure of double that amount.

The gear coupling can be adapted to special-purpose rolling operations in ferrous and non-ferrous blooming, strip, rod, sheet and structural rolling mills. The coupling is designed to establish a uniform wear pattern on the central portion of the gear teeth, while carrying a full work load — a factor that contributes to higher shock loading and improved torque-carrying capacity, regardless of operating angles.

Figure 1 — Uniformed polished wear pattern on fully-crowned teeth of an Amerigear spindle drive coupling illustrates the coupling's operating efficiency and balanced load-carrying ability in the pinch roll drive of coiler equipment at the 80-in. hot strip mill at U. S. Steel's Irvin Works.

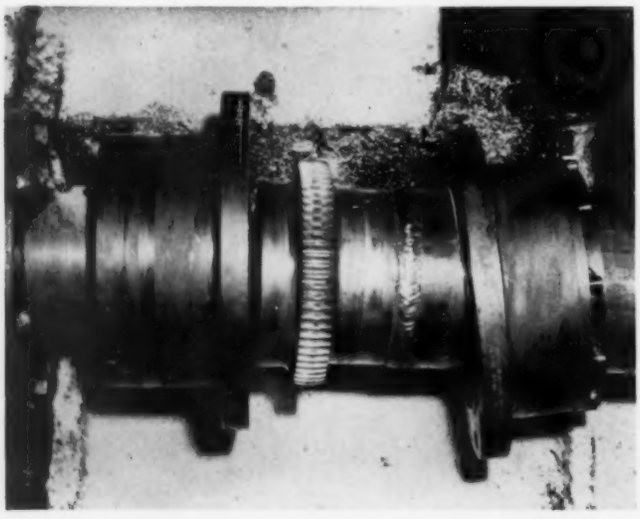
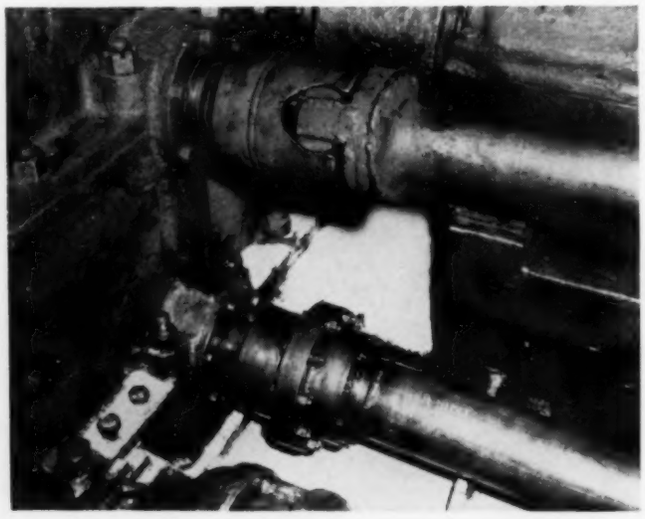
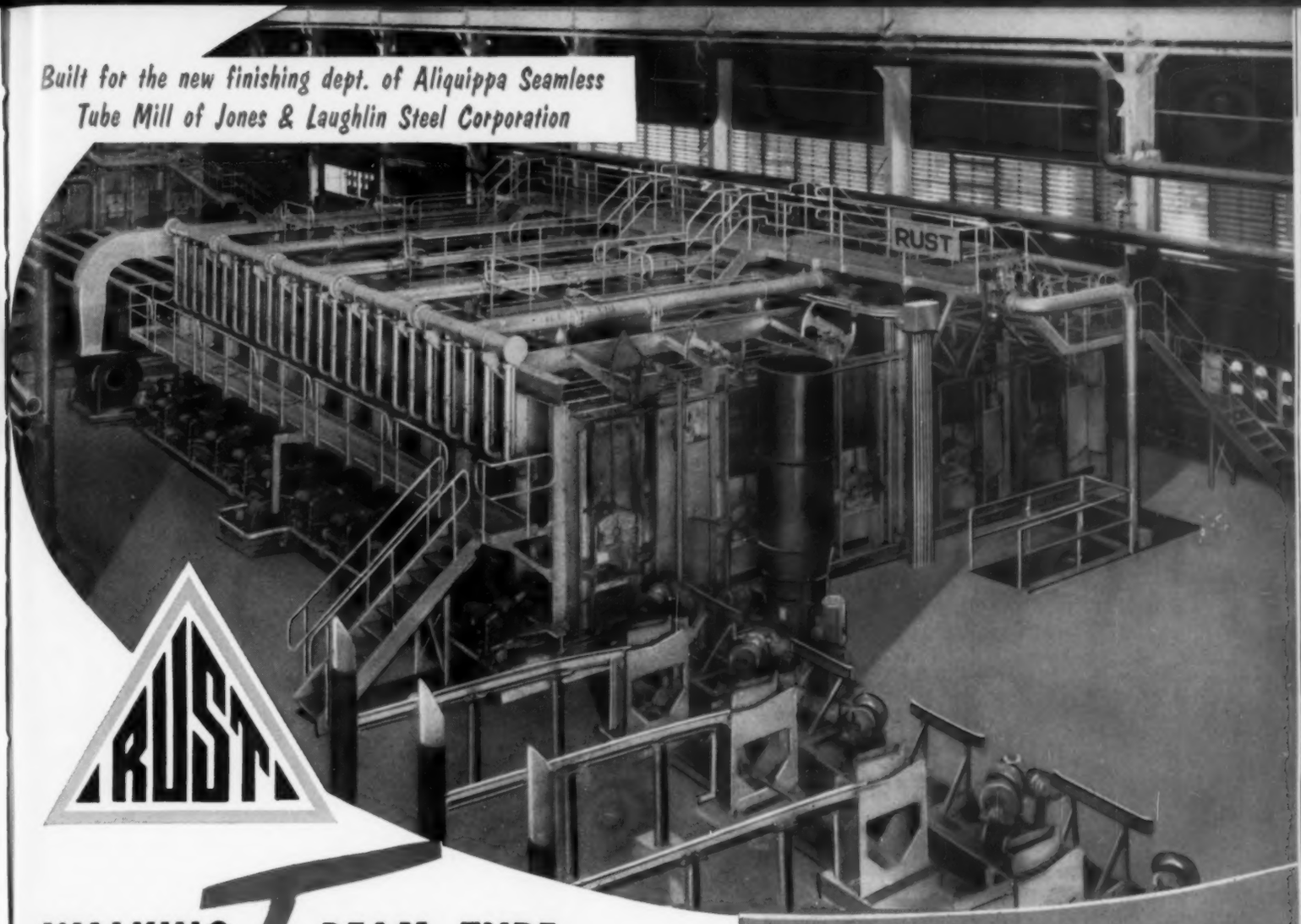


Figure 2 — Mill officials at the 80-in. hot strip mill at the Irvin Works report that periodic greasing is the only maintenance requirement for the gear spindle drive coupling (lower portion of photograph) serving in the pinch roll drive of the mill's coiler equipment. Maintenance of the conventional universal coupling (upper half of photo) is relatively costly.



Built for the new finishing dept. of Aliquippa Seamless Tube Mill of Jones & Laughlin Steel Corporation



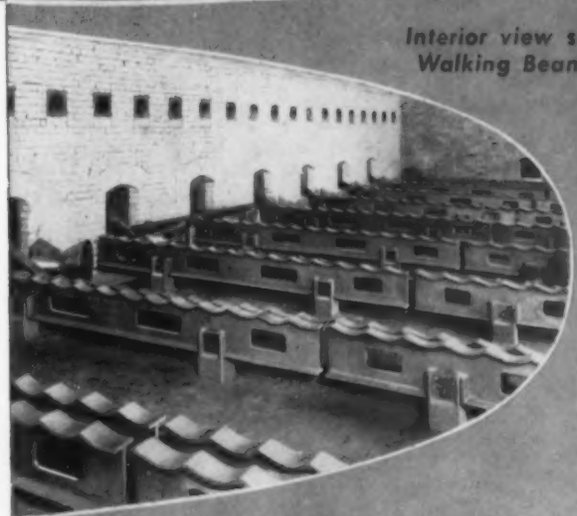
RUST

WALKING BEAM TYPE HEAT TREATING *Furnaces*

For heat treating their seamless tubing, the Jones & Laughlin Steel Corporation chose two specially-designed Rust furnaces as shown above. These walking beam type furnaces were designed and constructed by Rust in record breaking time—and they are helping the new "J & L" Seamless Tube Finishing Department to break records in producing, conditioning, and finishing high tensile strength seamless tubes.

Be sure to consult Rust on any problem of tube and pipe annealing, heat treating, and processing. Rust also designs and builds other type furnaces to meet every metallurgical heating need.

*Interior view showing Walking Beam Rails**



FIRST *installation of this type for Normalizing, Quenching and Drawing of Seamless Tubes*

*Walking Beam Rails designed and furnished by York-Gillespie Mfg. Co.

THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything, from original idea to start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

Rust Furnace Company

Pioneers in Furnace Design

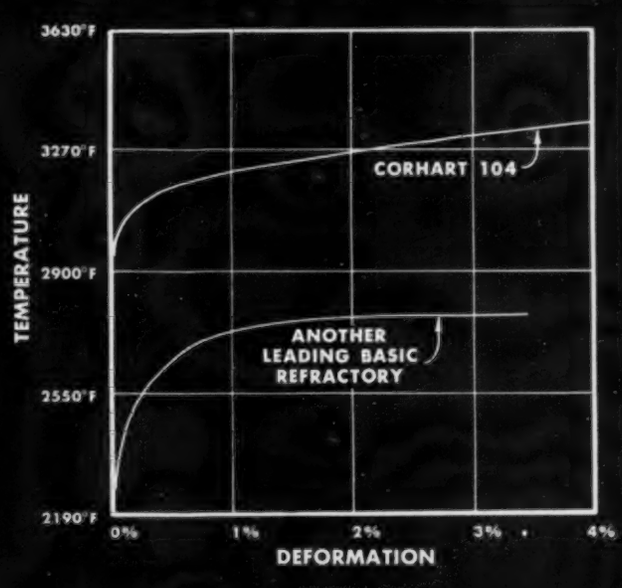
Rust Building • Pittsburgh, Pa.

ELECTRIC FURNACE OPERATORS—

How Much Money Would Longer Furnace Life Make for You?

BECAUSE Corhart 104 Electrocast refractory castings are poured at 4400°F, because Corhart 104 has high hot strength, because *other* electric furnace operators are getting longer life and greater output from furnaces REINFORCED with Corhart 104 . . . *we think you can too!*

Let's talk facts on Corhart 104 as applied to *your* operation. Write or phone . . . and *you* name the time and place! Corhart Refractories Co., *Incorporated*, 1640 West Lee Street, Louisville 10, Kentucky, U.S.A. Telephone — CYpress 4471.



QUALITY ECONOMY ENDURANCE

CORHART 104 ELECTROCAST REFRACTORY

The words "CORHART" and "ELECTROCAST" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, *Incorporated.*

Figure 1 — A main bay of the Ellwood City, Pa. plant of the Aetna-Standard Engineering Co.

Figure 2 — Commercial assembly floor and fabricating shops.

Equipment Builder Unveils Expansion Program

▲ THE Aetna-Standard Engineering Co., Pittsburgh, Pa., unveiled on October 12th, their fourth major expansion in recent years at their Ellwood City, Pa., plant. The newest expansion adds approximately 40 per cent to production capacity with the increase concentrated on machining, welding and assembly facilities. The expansion includes the installation of a new power plant and control equipment, increasing the kva load capacity from 300 kva to 750 kva. Many new machine tools have been installed and the plant completely repainted by the color dynamics method. The total cost for the expansion is estimated at two to three million dollars.

Last major expansion for Aetna-Standard was 1951 when the engineering and general offices were transferred from Youngstown, Ohio, to Ellwood City, Pa. A new office building was constructed. At that time, the Ellwood plant was enlarged to include a new roll foundry. Many new machine tools were added. At the same time, the executive personnel moved to Pittsburgh from Youngstown. There were other major expansions in 1947 and 1940. During these fifteen years, employment has grown from 375 to 1200.

Aetna-Standard builds machinery for the steel, copper, brass, aluminum, rubber and plastic industries. Major products include: continuous galvanizing and electrolytic tinning lines; side trimming and shear lines and other finishing equipment; continuous butt weld pipe mills; seamless pipe and tube mills; drawbenches and auxiliary equipment; rolls and castings; extruders, mills, presses and other products for rubber and plastic.

Kaiser Aluminum to expand manufacturing facilities

▲ A $90,000,000 expansion program involving five of the company's principal manufacturing plants is now underway, Kaiser Aluminum & Chemical Corp. announced recently following completion of financing arrangements.

Major emphasis in the new program centers on the corporation's plant at Ravenswood, W. Va., where an additional $75,000,000 is being spent to enlarge and complete the initial facilities now under construction as a fully integrated sheet and foil rolling mill by early 1957 — more than a year ahead of the original timetable.

The huge Ravenswood works will represent an investment of approximately $100,000,000. It will have an annual capacity of 333,500,000 pounds of commercial sheet and foil products 320,000,000 pounds of sheet and 13,500,000 pounds of foil — as compared with the 250,000,000 pounds of capacity originally planned.

(*Please turn to page 164*)

"When our main feeder single-phased, we did not lose a motor — FUSETRON DUAL-ELEMENT FUSES saved them"

"In October, 1952, we had quite a demonstration on how Fusetron dual-element fuses can prevent motor burn outs.

"Fusetron fuses that we were using to back up our motor protection began popping out all over the plant because our main feeder circuit had single-phased.

"Before we could dump the whole plant by pulling the main switch, sixty-seven Fusetron fuses had opened.

"We did not lose a single motor, however, and while it was some trouble to us to replace all the blown Fusetron fuses, we would rather do that than repair one burned out motor.

"We are convinced that Fusetron fuses used to back up our other motor protection, give us a distinct advantage in saving time and money.

Samuel T. Craig CHIEF ELECTRICAL ENGINEER
JUDSON L. THOMSON MANUFACTURING CO.
WALTHAM, MASSACHUSETTS

FUSETRON dual-element FUSES DO MORE THAN PROTECT MOTORS AGAINST BURNOUT DUE TO SINGLE PHASING

. . . They provide 10 Point Protection

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.

2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.

3. Protect against needless blows caused by harmless overloads.

4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5. Protect against waste of space and money — permit use of proper size switches and panels.

6. Protect motors against burnout from overloads.

7. Give DOUBLE burnout protection to large motors — without extra cost.

8. Protect motors against burnout due to single phasing.

9. Make protection of small motors simple and inexpensive.

10. Protect coils, transformers and solenoids against burnout.

AND FUSETRON FUSES REMAIN SAFE

without maintenance and recalibration costs

Once properly installed, Fusetron fuses require no costly inspection time or maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

When a Fusetron fuse does open to protect, and after the fault has been corrected — the new Fusetron fuse you install has been calibrated at the factory by engineers — it is a fuse as safe and dependable as the one that blew.

Blowing time charts and more information are available on Fusetron dual-element fuses. Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . *Use BUSS Hi-Cap Fuses*

On 600 volts or less, they have interrupting capacity sufficient to handle any fault current regardless of system growth.

When coordinated with Fusetron fuses they will not open ahead of fuse nearest fault.

— Write for bulletin HCS —

Play Safe! *Install FUSETRON Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

1155

BUSSMANN Mfg. Co. *Division of McGraw Electric Co.*
University at Jefferson, ST. LOUIS 7, MO.

(*Continued from page 161*)

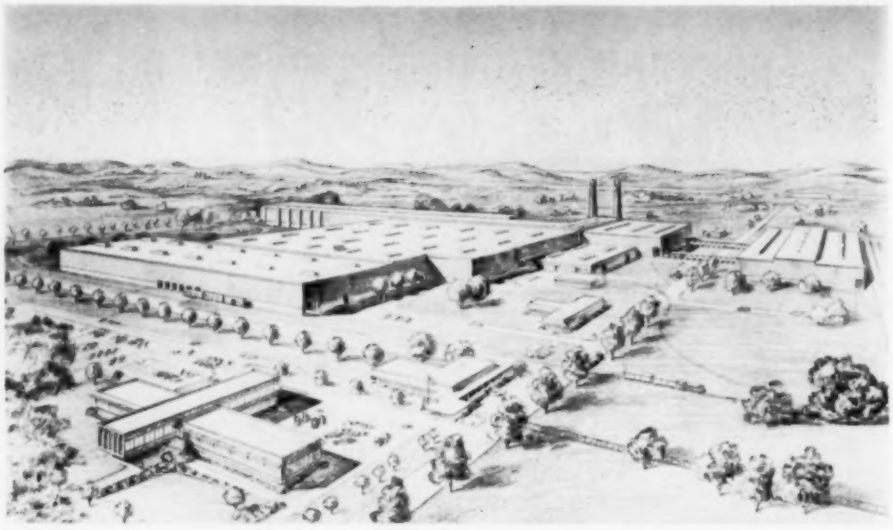
On completion the Ravenswood mill will be the largest capacity aluminum fabricating plant to be built in the United States since World War II.

The decision to expand Ravenswood faster and on a larger scale than first planned is based on the continued increase in demand for aluminum sheet and foil products.

The Ravenswood plant's central location — within a 500-mile radius of more than 70 per cent of the nation's aluminum usage, will enable Kaiser Aluminum to strengthen its competitive and service position.

In addition, the advantageous location of the Ravenswood works on a 2500-acre site on the Ohio River greatly consolidates the company's direct line raw material assembly flow in its ore-to-market operations. Some 5000 miles of current freight haul will be eliminated on sheet shipments to a major portion of the market. Freight costs on this movement will be reduced by 69 per cent.

This flow starts from the company's bauxite mines in Jamaica. The ore is shipped to the Baton Rouge, La., plant which processes it into alumina for use at the 400,000,000 pound annual capacity reduction plant at Chalmette, near New Orleans, which in turn will supply pig aluminum to Ravenswood.



Artist's sketch shows Kaiser Aluminum and Chemical Corp.'s integrated aluminum sheet and foil rolling mill now under construction on a 2500-acre Ohio river site near Ravenswood, W. Va.

MAJOR EQUIPMENT ORDERED

Orders totaling more than $21,000,000 have already been placed for major items of equipment and construction work for the Step II expansion of Ravenswood. United Engineering and Foundry Co., Pittsburgh, Pa., is building a 168-in. hot reversing mill, which will be the aluminum industry's largest, and a 100-in. 5-stand, 4-high continuous hot mill. Lewis Foundry, Division of Blaw-Knox Co., Pittsburgh, Pa., has been awarded a contract calling for two 4-high cold mills, a 72-in. 2-stand tandem mill and a single stand mill. Loewy-Hydropress, Inc., N. Y., is building a 110-in. hot reversing mill.

Also to be installed under the expanded program is a 72-in. wide foil mill, which is in addition to a 60-in. high-speed, light gage sheet mill and two 60-in. foil mills that are included in Step I.

Direct chill casting facilities will produce rolling ingots up to 10,000 pounds in weight — believed the largest ever used in the aluminum industry.

SITE PREPARATION UNDERWAY

Grading and other site preparation work have already been started on the enlarged main building at Ravenswood. Incorporating the initial cold rolling facilities, it will contain nearly 1,500,000 sq ft of floor space — some 32 acres — under roof.

During the construction period on Step II, employment on the project will reach a peak of more than 1500 persons, in addition to the 500 required to operate the initial cold rolling facilities. Some 2000 permanent operating personnel will be needed when the fully integrated plant begins production.

FOUR OTHER PLANTS BEING EXPANDED

Expansion of four of the company's other principal plants includes:

Increasing capacity of the recently purchased Halethorpe, Md., extrusion plant from 24,000,000 to 46,000,000 pounds per year by the installation of one 3250-ton and three 2750-ton presses.

Increase of 12,600,000 pounds of primary aluminum capacity at the company's Mead and Tacoma, Wash., reduction plants by the installation of additional reduction cells, thus raising the company's total primary capacity to 828,600,000 pounds per year.

Installation of a cryolite recovery plant and facilities for direct chill casting of billet at the Chalmette, La., reduction plant.

This $90,000,000 expansion program now underway is entirely separate from the corporation's recently announced consideration of future expansion of its bauxite, alumina and primary aluminum reduction capacities.

There is a demand for copies of the following Yearly Proceedings:

1935 1936 1937 1940 1952

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS. 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

DRAVO

DESIGNERS *and* BUILDERS

BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
FLOATING CRANES • DRAVO RAIL CLAMPS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES
WHIRLER CRANES • BARGE SHIFTERS
HYDRAULIC BUFFERS

Completely unloading 30,000 gross tons of ore in 30 hours is the typical performance of this new Dravo-designed and built ore unloader at The Marine Bulk Handling Corporation's Mobile, Alabama, terminal.

Ships from Venezuela and other foreign ports bring iron ore here for the Fairfield, Alabama plant of U. S. Steel's Tennessee Coal and Iron Division. The unloader has removed ore at a rate of 1800 tons per hour, using a 275 cubic foot capacity bucket with a hoist speed of 300 feet per minute. The smooth, fast performance is produced economically with the use of an adjustable voltage control system.

To find out how such a modern Dravo bulk material handling system cuts costs and increases production, accept our invitation to visit actual installations. There is no obligation for this service or for a copy of Bulletin 225 describing Dravo equipment. Write us today.

DRAVO
CORPORATION

Neville Island, Pittsburgh 25, Pennsylvania

Air Conditioning • Boiler and Power Plants • Crane Cab Coolers • Docks • Industrial Foundations • Open Steel Flooring
Pump Houses and Intakes • Space Heaters • Water and Waste Treatment Plants • Towboats and Barges

TRANTINYL mill guides . . S

TRANTINYL Guides the Steel Industry

SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc.

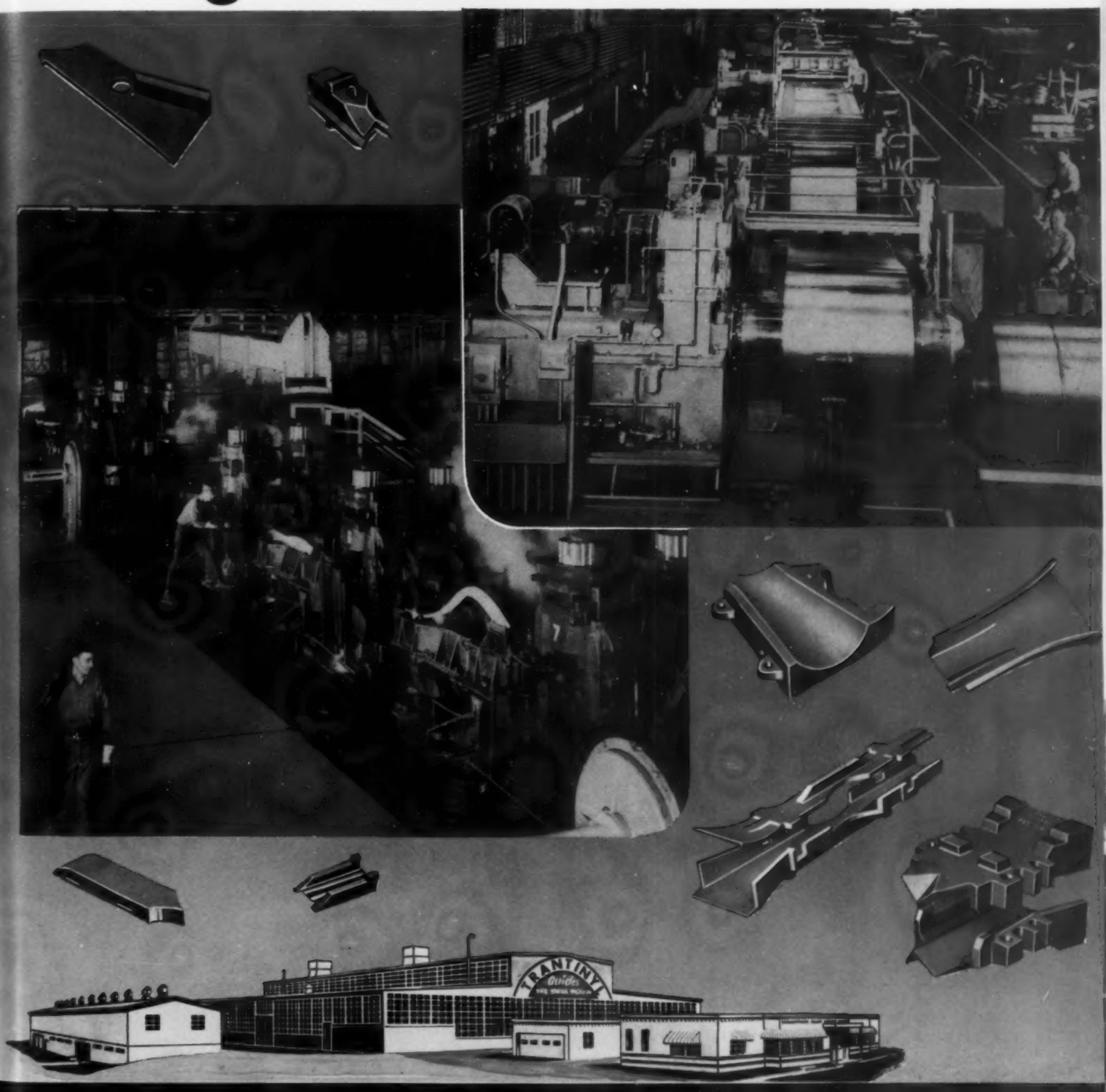
ROLLING MILLS: bar, hoop, strip, shape mill guides; and rollers

STRAIGHTENING MACHINE GUIDES · HEAT RESISTING CASTINGS

TRANTINYL QUALITY DISTINCTION

"TRANTINYL Alloy Steels have no equal in tonnage rolled per set of guides"

..serving J&L and other steel makers for over 20 YEARS



YOUNGSTOWN ALLOY CASTING CORPORATION • Youngstown, Ohio

Sole Licensee to cast "TRANTINYL" for the Midwest, West and South: WAUNAKEE ALLOY CASTING CORP., Waunakee, Wis.

J&L Announces Major Additions to Expansion Program

▲ Jones & Laughlin Steel Corp. will step up its expansion program sharply, increasing its annual ingot capacity over 700,000 tons, and bringing to over $250,000,000 its expenditures for improvement and expansion projects in the period 1955-58.

This was announced on October 28 following a meeting of the board of directors of J&L at the Cleveland Works of the corporation.

The corporation had previously announced that it would spend $135,000,000 during the two-year period 1955-56 on improvements and expansion. This last announcement of J&L's plans for the four-year period through 1958 adds over $115,000,000 to the earlier-announced total.

J&L's present annual ingot capacity is approximately 6,200,000 tons.

The new program will expand ingot capacity at J&L's Cleveland Works by about 400,000 tons a year and at Aliquippa Works by approximately 300,000 tons a year.

The increase at Cleveland will be accomplished by improvements in the present open hearth facilities at the works and by the addition of two new electric furnaces.

Changes and improvements scheduled to be made in the processing and finishing units of the Cleveland Works will more than double the present capacity for the production of cold rolled sheets and will greatly increase the efficiency of the processing and finishing units for both hot rolled and cold rolled sheets.

Major new facilities at Cleveland Works, in addition to the two new electric furnaces, will include a blooming mill, additional soaking pits, a reversing roughing mill, a continuous pickler, a four-stand tandem cold-reducing mill, additional annealing, tempering, and shearing facilities and a processing line for hot rolled products.

This is the largest improvement program approved for the Cleveland Works since its acquisition by Jones & Laughlin in 1942.

Westinghouse Electric Corp. is the recipient of contracts for electrical equipment for several of the important units in the program, including the blooming mill, the universal roughing mill, and two electric melting furnaces; electrical equipment for the big four-stand tandem cold reducing mill and other important items will be built by General Electric Co.

The contemplated blooming and slabbing mill at Cleveland Works, for which Westinghouse will provide the electrical equipment, will be powered by two 5000-hp motors. The universal roughing mill will require motors totalling 9500 hp capacity.

The four-stand tandem cold reducing mill, which will be powered by General Electric, will have motors totalling approximately 22,000 hp. This new unit will be used in the production of cold rolled sheets and will be as powerful as any of its kind in the steel industry.

At Aliquippa Works, two oxygen blown converters—the latest development in steelmaking processes—will be installed as an additional part of the large program already going forward at this plant. J&L will be the second steel company in the U. S. to use the new, revolutionary oxygen converters. J&L's Aliquippa plant, with its high ratio of pig iron to steel ingots, is in a very favorable position to use the new steelmaking process.

In addition to the oxygen converters, improvements will be made in the soaking pits at Aliquippa to handle larger tonnages of ingots.

The program which was announced earlier this year by Jones & Laughlin for its Aliquippa Works includes a new strip mill, and major changes and additions to the pipe and tube departments.

J&L has negotiated an additional $15,000,000 bank credit, supplementing a $35,000,000 credit arranged with banks earlier this year under which no borrowings have yet been made. The company expects to handle the balance of the requirements for the program from its own resources.

Work on the new projects is expected to begin immediately.

The Cleveland and Aliquippa programs are expected to be finished in 1957.

The earlier-announced Aliquippa program is already under way and a large portion of it is scheduled for completion in 1956.

At J&L's Pittsburgh Works, the new continuous galvanizing unit is expected to be in production in January, 1956.

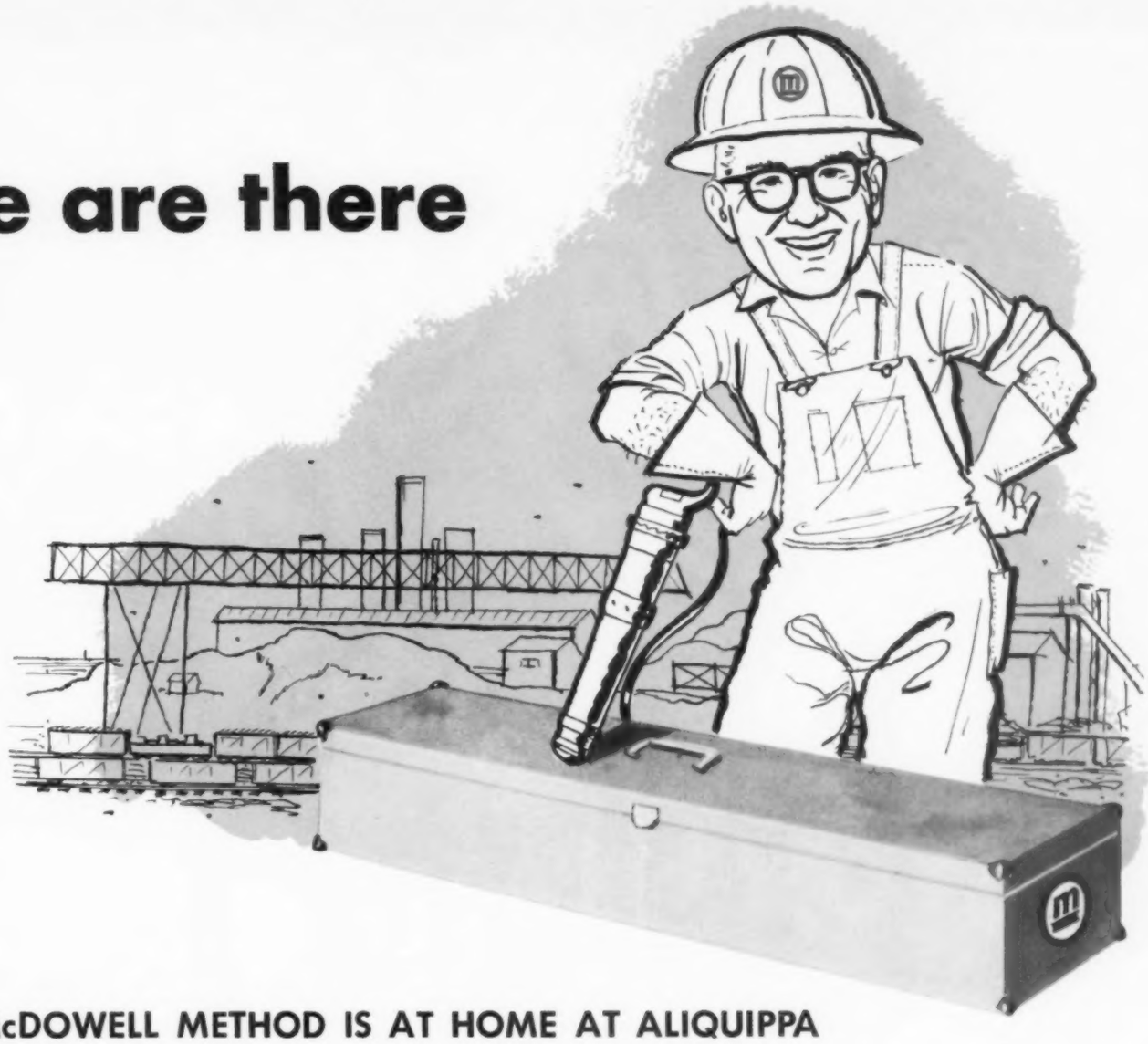
The new program, plus other projects, will bring to a total of over $250,000,000 the funds J&L expects to invest in improvements and enlargements to its production capacities in the period 1955-58. Including this amount, the total funds spent by J&L on improvements and expansion since the end of World War II will be more than $700,000,000.

1956 AISE SPRING CONFERENCE

April 30, May 1, 2

Lord Baltimore Hotel Baltimore, Md.

we are there

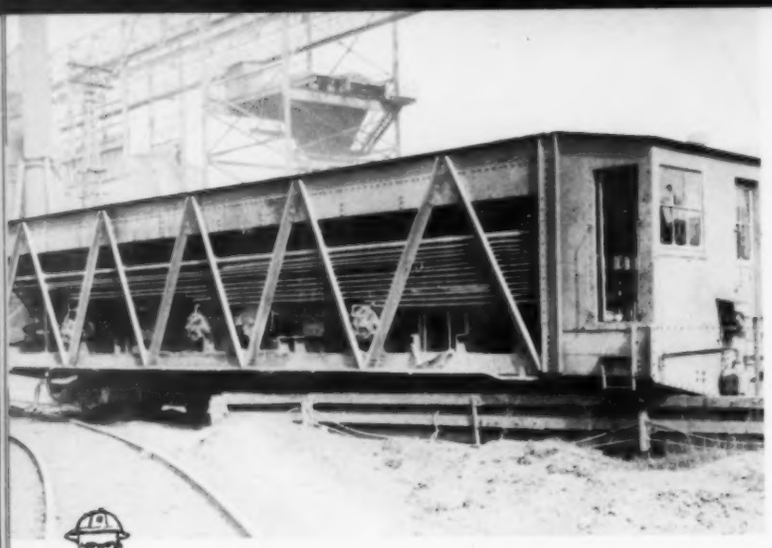


THE McDOWELL METHOD IS AT HOME AT ALIQUIPPA

WE ARE THERE in the complete Wean electrolytic cleaning and tinplating plants, installed turnkey.

WE ARE THERE in the 13¼ ton man trolley ore handling bridge, engineered and built by Wellman.

and



WE ARE THERE in the special 60 ton coal transfer car, Wellman engineered and built.

WE ARE THERE in the many Williams ore buckets, Wellman engineered and built.

McDOWELL

McDOWELL COMPANY, INC. and FAMILY

The Wellman Engineering Company with its Williams Bucket Division

McDOWELL COMPANY, INC. • CLEVELAND 2, OHIO, U.S.A.

DWIGHT-LLOYD DIVISION
CLEVELAND 10, OHIO, U.S.A.

TRANSPORTOMETER DIVISION
CLEVELAND 10, OHIO, U.S.A.

McDOWELL COMPANY, INC. • RIVERSIDE DIVISION
MARTINS FERRY, OHIO, U.S.A.

THE WELLMAN ENGINEERING COMPANY • CLEVELAND 4, OHIO, U.S.A.

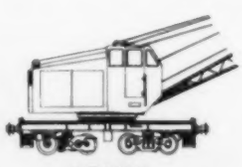
WILLIAMS BUCKET DIVISION
CLEVELAND 4, OHIO, U.S.A.

LOCOMOTIVE CRANE DIVISION
CLEVELAND 4, OHIO, U.S.A.

ANKER-HOLTH DIVISION
PORT HURON, MICHIGAN, U.S.A.

TRANSPORTOMETER ®
Automatic Materials Weighing

DWIGHT LLOYD ®
Sintering Plants



WELLMAN
Locomotive Cranes

ANKER-HOLTH
Power Cylinders

BALLWELL ®
Flying Saucer

THE McDOWELL METHOD IS A COMPLETE ENGINEERED CONSTRUCTION SERVICE FOR BASIC INDUSTRY

J&L Dedicates New Research Laboratory

▲ Jones & Laughlin Steel Corp. dedicated its new research laboratory in Pittsburgh on October 28. It was named "The Graham Laboratory for J&L Research" after Herbert W. Graham, a leader in industrial research at J&L for over 40 years.

The laboratory, which cost over $1,500,000, contains the most modern equipment for handling the research problems of a steel company. It is the most recent step in J&L's continuing post-war expansion and improvement program, which by the end of 1955 will have cost over $500,000,000.

The new building, with a total floor area of about 40,000 sq ft, is located in the City of Pittsburgh on Baldwin Hill, South Side, between Becks Run Road and Glass Run Road. It stands on a five-acre site, part of a 700-acre tract owned by J&L, overlooking J&L's Pittsburgh Works on both banks of the Monongahela River just upstream from Pittsburgh's Golden Triangle.

Construction of the laboratory began in July, 1954.

The broad scope of research activity is serviced by the most modern equipment for physical testing, metallographic studies, X-ray diffraction, spectrographic analysis, and analytical chemistry. Investigative programs cover all phases of J&L's operations from raw materials processing, iron and steelmaking, production of finished steel products, organic chemical processing, and development of new instruments for automation and quality control.

Earlier this year J&L announced a research development of importance in the steel industry. This was a successful laboratory-scale pilot plant, at the ore research laboratory at Negaunee, Mich., for the up-grading of non-magnetic taconite ore containing about 35 per cent iron to a usable concentrate containing as much as 66 per cent iron by means of a reduction-magnetic separation process.

The laboratory also houses the administrative activities of the research division; a 3500-volume library; accounting and purchasing offices, and a fully-equipped machine shop.

Currently the total research division staff numbers 127 people, some of whom remain at the steelmaking and coal chemicals laboratories adjacent to the Hazelwood section of J&L's Pittsburgh Works, and others who operate the division's ore research laboratory at Negaunee, Mich.

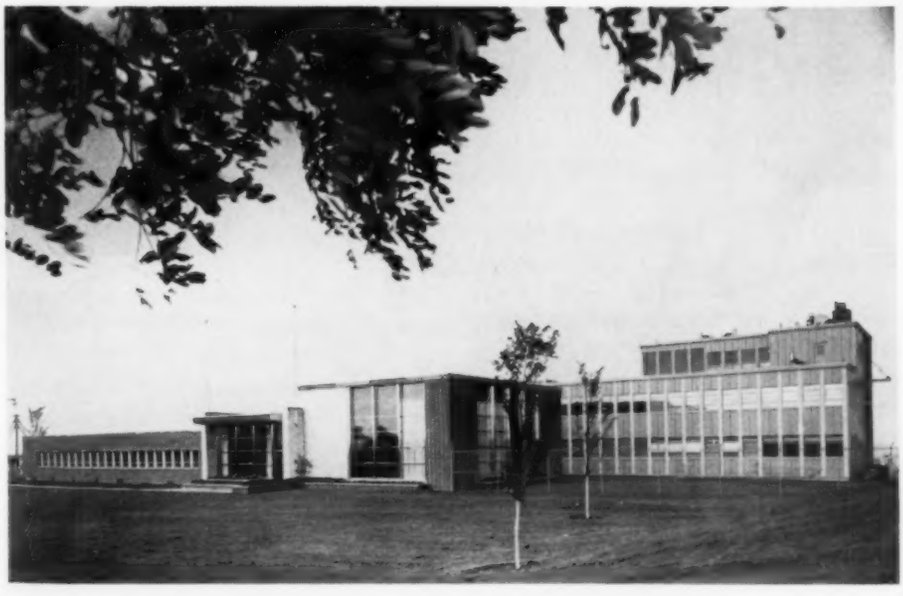


Figure 1 — Jones and Laughlin Steel Corp.'s new $1,500,000 research laboratory on Baldwin Hill, South Side, Pittsburgh, has a floor area of about 40,000 sq ft. Construction began in July 1954.

Figure 2 — Machine shop of new research laboratory can make custom-tailored pieces of special equipment often required in modern steel research. The machine shop is in the basement of the new laboratory, along with maintenance shops, boiler rooms, a records filing section and storage areas.

INLAND STEEL ANNOUNCES MAJOR ADDITIONS TO EXPANSION PROGRAM

▲ Inland Steel Co. announced on October 31 a three-year expansion program for its basic steel plant at East Chicago, Ind., that will lift its steelmaking capacity 15 per cent to 6,000,000 tons of ingots annually by 1959.

Included also will be a new blooming mill with initial capacity that will be more than enough to handle the added steel output, and so designed that eventually it can almost double the plant's present blooming facilities.

Another major item will be a second completely new cold rolled sheet department which will ultimately double the present output of this product. Immediate plans call for an increase of approximately 50 per cent by 1959.

In addition, the program includes a substantial increase in the capacities of the hot strip mills, a continuous normalizing line for enameling sheets, and big increases in power facilities and auxiliary equipment.

In combination with other improvement and replacement projects at the steel plant and elsewhere, including such already announced items as the large Steep Rock Lake, Ontario, iron mine development, and the new Chicago general office building, the three-year program is expected to involve a total of $260,000,000.

The newly announced program accelerates the company's steady rate of growth. Capital expenditures in the current year will reach $45,000,000, the greatest in any year in the company's history up to this time.

In ten years of postwar expansion, investments in plant and equipment have totalled $280,000,000, slightly more than the expenditures planned for the next three years. In the 1945-1954 period, the company's steelmaking capacity has been raised from 3,400,000 ingot tons annually to its present 5,000,000-ton annual rating, which will be further increased to 5,200,000 as of January 1, 1956.

Three new 315-ton open hearth furnaces, larger than any of the company's present 40 furnaces, will be built to provide most of the 800,000 tons to bring annual capacity to 6,000,000 tons. The remainder of the increase will be obtained from improvements in existing furnaces and in production techniques. The company has stretched its steelmaking capacity a total 700,000 tons in the last three years by remodeling of old furnaces and improving material handling and operating methods.

The new blooming mill to roll ingots into slabs preparatory to their reduction in the strip mills will handle 1,800,000 tons of steel annually, or more than twice the contemplated increase in ingot capacity. Furthermore, it will be so designed that it can subsequently be equipped to roll 4,750,000 tons of ingots annually. The company's three present bloomers will have a combined capacity of 5,500,000 tons a year when current projects to improve their operations are completed.

The new mill goes beyond immediate needs and will provide the plant blooming capacity far into the future.

By 1959 the new cold rolled department will be capable of turning out 485,000 tons a year of such products as cold rolled sheets, enameling iron sheets and electrical sheets, all of which are used extensively by manufacturers of automobiles, home appliances, and other consumer goods. It will have a four-stand tandem mill and its ultimate capacity can be lifted to 790,000 tons a year at some time in the future by the construction of additional auxiliary processing facilities.

The company's present capacity for these products is 850,000 tons a year.

A program of improvements to present blast furnaces is included in the three-year project to increase supplies of pig iron for the steelmaking process, without the construction of new furnaces.

When completed, the program will have created 1,750 new jobs.

The company will undertake some public financing as the program progresses, but none will be undertaken in 1955.

Inland demonstrated a new semi-automatic mill for rolling wide flange beams recently at its Indiana Harbor Works. Current production of the mill is limited to trial runs of beams in 8, 10, and 12-in. sections. It is designed to produce sizes ranging from 8 to 24 in.

Electronic advances incorporated into the new mill include automatic controls which can be preset to adjust the position of the rolls so that the operator is freed from some of the manual operations required in older type mills.

Inland's entry into the wide flange beam business will round out the company's production of items for the construction industry, which include standard structural shapes such as I-beams, H-beams, angles, channels, steel sheet piling, and concrete reinforcing bars.

Facilities for producing the new shape have been built by revamping the plant's 28-in. structural mill which had a rolling record spanning two World Wars.

The revamping meant that new machinery and equipment was purchased and installed, some present facilities were relocated and several building extensions were built.

Heart of the wide flange beam operation is a 44-in. universal beam mill and a 34-in. edging mill, operated in tandem by one operator. A new 6000 hp electric motor was installed to drive them.

Other new equipment included a 40-in. finishing mill, a 175-ton crane, a 66-in. hot saw and a 66-in. cold saw, new gag press and new roller straightener.

To handle the new product, a 220-foot building extension was erected to store wide flange beam rolls; another building was extended 220 feet and a new 640 foot warehouse building was built to house the finishing processes.

Jones & Laughlin Expands Pipe and Tube Capacity

EIGHT NEW SUTTON STRAIGHTENERS PURCHASED FOR USE AT J&L ALIQUIPPA WORKS

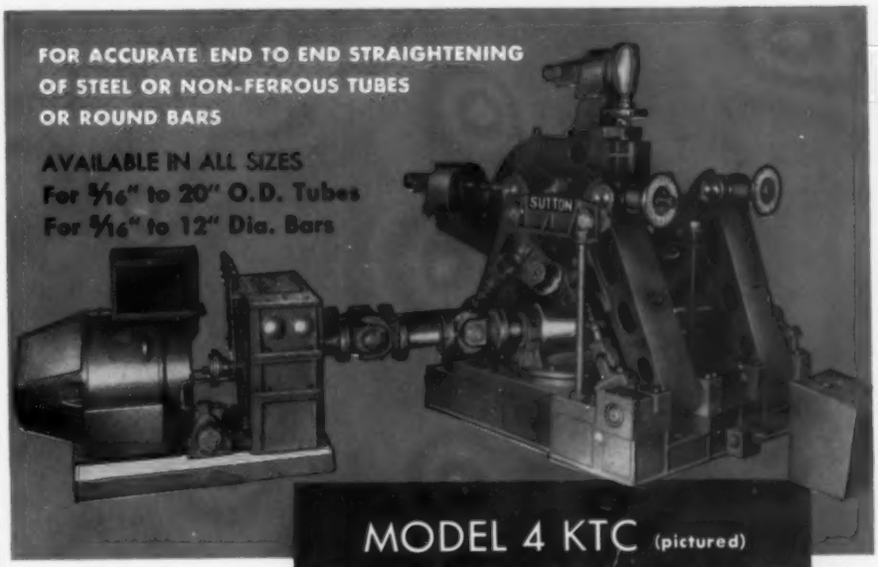
A Model 4KTC Sutton 7-Roll Straightener, as pictured at right, has been installed in the seamless tube specialties department of Jones and Laughlin Steel Corporation's Aliquippa Works. It has been selected as the best machine available to straighten heat-treated oil country tubular products of from 4½" to 9⅝" O. D. in 16 to 50 foot lengths with both plain and upset ends.

Another Sutton 7-Roll Straightener, Model 3½KTC, is being installed in the seamless tube mill for straightening plain and external-upset tubing and J & L integral joint tubing. Both of these 7-roll machines feature quality guideless straightening at high production speeds with a minimum of time required for size changes.

Six additional Sutton Straighteners have been ordered for the new Jones and Laughlin continuous weld pipe mill at Aliquippa. In Mill No. 1, two No. 2 JM Special High-Speed Straighteners are to be installed directly in the mill line for ½" to 1½" pipe. With operating speeds up to 900 feet per minute they will handle the full mill production. A third No. 2 JM Special High-Speed Straightener is to be used at Mill No. 1 for job lot straightening. At Mill No. 2, two Sutton 2BM Modified High-Speed Pipe Straighteners are to be installed directly in the mill line for operation at speeds up to 500 feet per minute to handle full mill production of 1¼" to 4" pipe. Also, at Mill No. 2, a Model 2J Modified Pipe Straightener will be used to straighten 2" to 6" galvanized pipe.

All of the straighteners installed or being built for J & L, are standard or modifications of standard straighteners now offered the ferrous and non-ferrous metals industries by Sutton Engineering Company, pioneers and specialists in the field of precision straightening.

NEW SUTTON 7-Roll STRAIGHTENERS


FOR ACCURATE END TO END STRAIGHTENING
OF STEEL OR NON-FERROUS TUBES
OR ROUND BARS
AVAILABLE IN ALL SIZES
For 5/16" to 20" O.D. Tubes
For 5/16" to 12" Dia. Bars
SUTTON
MODEL 4 KTC (pictured)
TUBES FROM 3⅝" O.D. to 12" O.D.
BARS FROM 3⅝" to 7½" Dia.

Patented cluster roll arrangement positively confines work to pass line from entry to delivery without guides. Roll angles are automatically adjusted to proper setting with full contact between work and rolls.

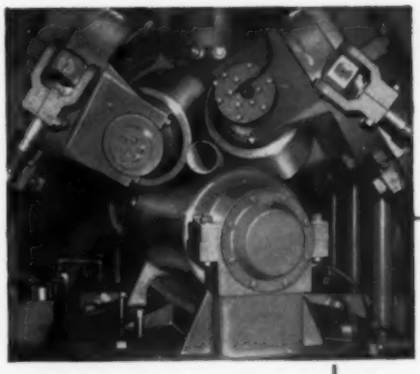


Photo and diagram of 7-roll design shows engineering principle of cluster roll arrangement.

- TRULY GUIDELESS
- HIGH PRODUCTION
- QUALITY STRAIGHTENING

STRAIGHTENS
EXTERNAL UPSET
TUBING, CASING, DRILL PIPE
20 TO 50 TIMES FASTER!

Ask for Bulletin No. 25

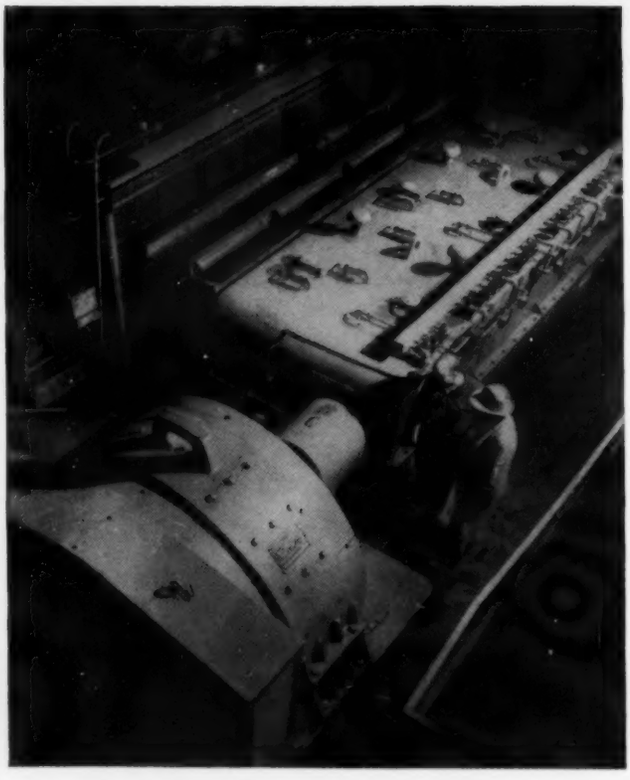
SUTTON *Engineering* COMPANY

Manufacturers for Ferrous and Non-Ferrous Metal Industries

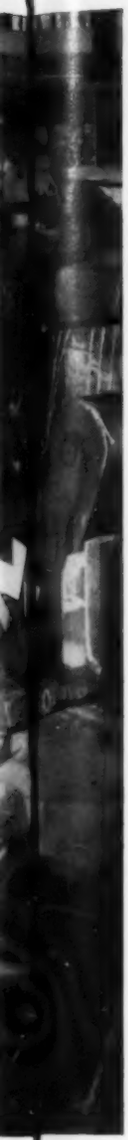
STRAIGHTENERS, EXTRUSION PRESSES, HYDRAULIC STRETCHERS, SHEET LEVELERS, CONTOUR CORRECTING MACHINES, STRAIGHTENING PRESSES, ROTARY CLEANERS, HEAVY-DUTY UNIVERSAL JOINTS, ROLLS

FIRST NATIONAL BANK BLDG., PITTSBURGH 22, PENNSYLVANIA
PHONE: GRANT 1-8077 PLANT: BELLEFONTE, PA.

Mr. H. T. Anderson, Jones & Laughlin Lubrication Engineer and Gulf Sales Engineer C. D. Gilchrist discuss lubrication of the 11-inch rod mill. Gulf E.P. Lubricants provide effective protection for the pinion stands and gear drives, while Gulf XXX Lubricant safeguards the roll neck bearings.



Finishing train pinion stands also get effective lubrication with Gulf E.P. Lubricants.



Jones & Laughlin uses the extreme pressure lubricants that provide *protection plus*...

Gulf E. P. Lubricants

Protection plus means that in addition to their extra load carrying capacity, their ability to prevent scoring and welding, Gulf E.P. Lubricants have other advantages that help Jones & Laughlin and many other steel companies get more effective lubrication and lower maintenance costs.

Gulf E.P. Lubricants have excellent water separating and rust preventive properties, exceptional stability, and effective nonfoaming and noncorrosive characteristics. And because of Gulf E.P. Lubricants' superior film strength, it is often possible to reduce the number of lubricants needed and simplify your storage and handling.

When you next order gear drive lubricants, make it an order for safe, sure protection and lower maintenance costs—specify Gulf E.P. Lubricants.

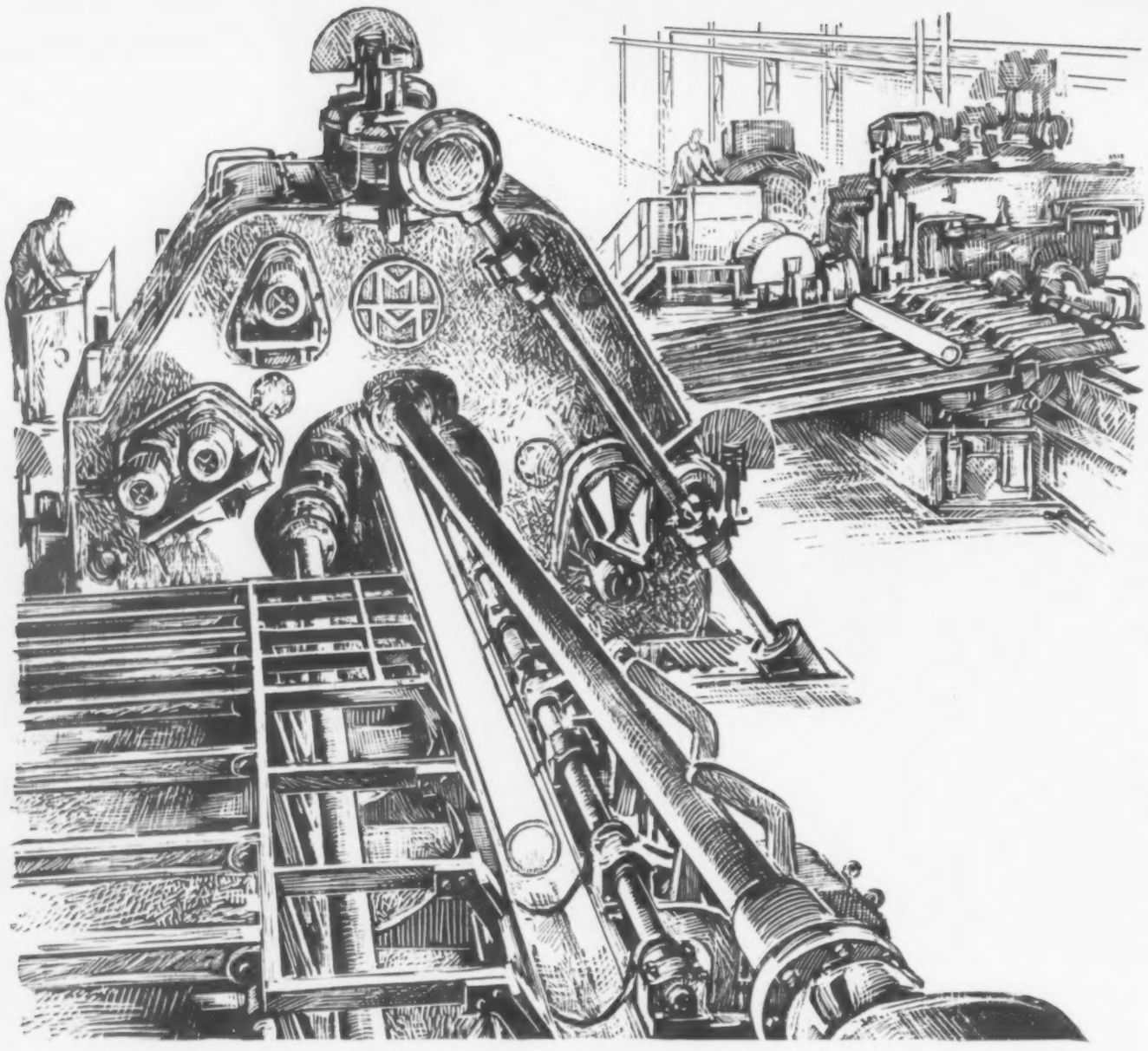
For expert help on any lubrication problem, call in a Gulf Sales Engineer. You will find him always on call. Consult the telephone directory for the number of your nearest Gulf office.

GULF OIL CORPORATION • GULF REFINING COMPANY

1822 GULF BUILDING, PITTSBURGH 30, PA.

GULF

THE FINEST PETROLEUM PRODUCTS FOR ALL YOUR NEEDS



THE WORLD'S LARGEST ASSEL MILL

This mill, recently shipped by Mannesmann-Meer, is another example of their engineering and manufacturing capabilities. Supplied to one of the world's foremost bearing manufacturers, this mill is capable of rolling up to $8^1/_2$" OD., heavy wall shells, and it has many design and operating features not available on previous assel mills.

Progressive thinking backed by over 65 years of experience in mill operating and mill design makes it possible for Mannesmann-Meer to offer you a combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

which is available nowhere else. Call today and put us to work on your more difficult problems.

MANNESMANN-MEER

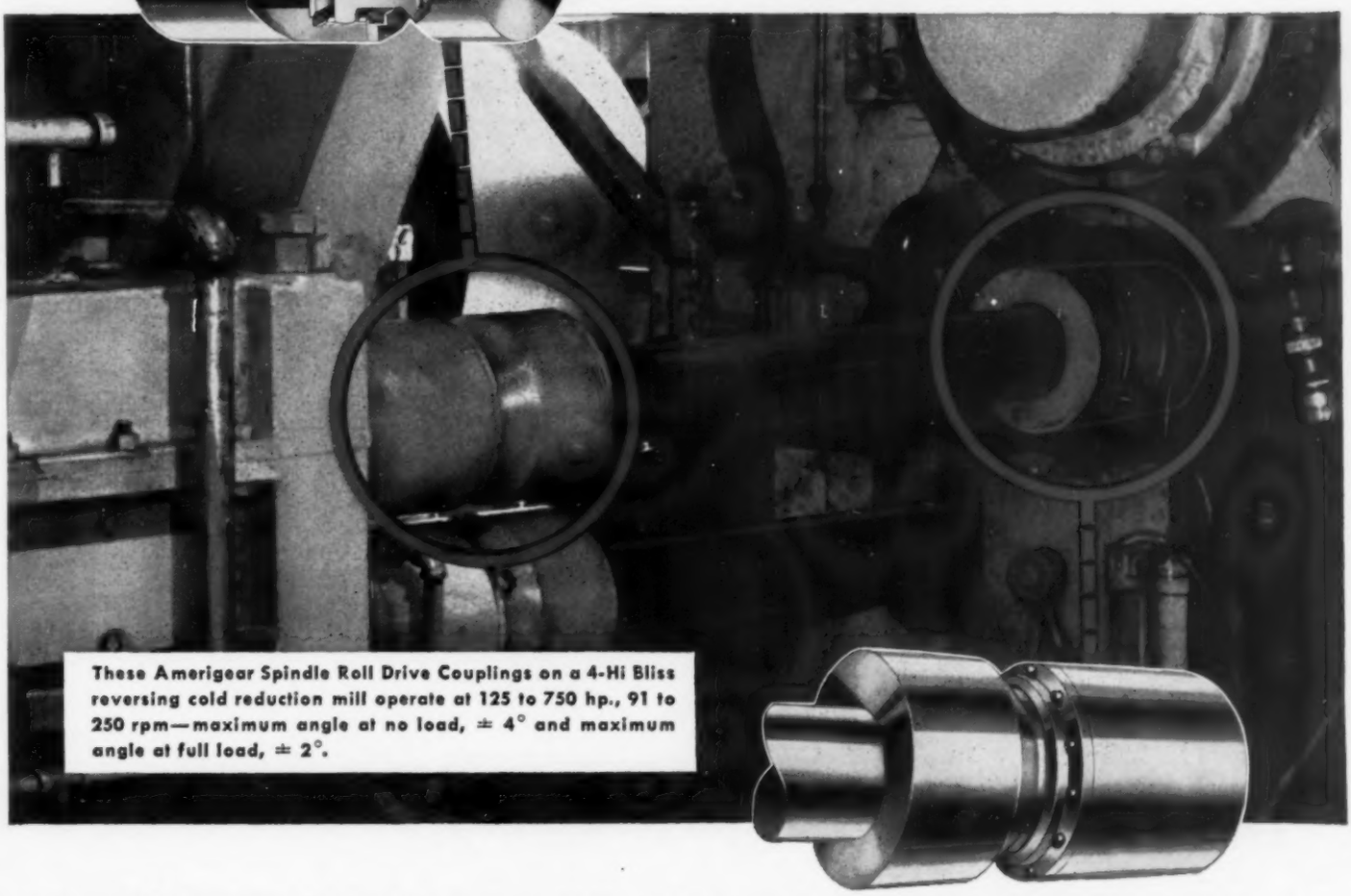
ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY

TROUBLED WITH "SLIPPER-TYPE" COUPLING FAILURES?
CONVERT TO
Amerigear® SPINDLE ROLL DRIVE COUPLINGS

. . . RUN LONGER WITHOUT MAINTENANCE

. . . MAKE ROLL CHANGES FASTER



These Amerigear Spindle Roll Drive Couplings on a 4-Hi Bliss reversing cold reduction mill operate at 125 to 750 hp., 91 to 250 rpm—maximum angle at no load, ± 4° and maximum angle at full load, ± 2°.

• HERE'S THE ANSWER TO YOUR HIGH MISALIGNMENT PROBLEMS . . .

Amerigear's Fully-Crowned Tooth Form concentrates the load towards the center of the tooth, eliminates tooth end and tip loading. This permits an extremely high degree of angular and lateral misalignment—up to ± 9° per engagement—with no wear or loss of power.

And By Accommodating For Roll Wear and varying distances between roll centers, Amerigear Spindle Roll Drive Couplings keep your maintenance expenses to a minimum. That's because they're precision-manufactured to transmit power to the rolls smoothly and continuously . . . even after repeated roll grinding . . . *without maintenance.*

Downtime Goes Down, Too because engaging roll end teeth are specially designed for quick assembly and disassembly. So the next time you're in need of flexible couplings for your ferrous or non-ferrous rolling mills, convert to Amerigear — a highly engineered solution to your every high misalignment problem.

Amerigear Engineers are ready to help you design improved operating efficiency into heavy presses, slitters, cranes, reels or other steel mill equipment. Write for Catalog 501 and Bulletin 1052, or attach coupon below to your letterhead.

COPYRIGHT 1955

SOLD IN PRINCIPAL CITIES BY

Amerigear ZURN INC.

AMERICAN FLEXIBLE COUPLING COMPANY
ERIE, PA., U. S. A.
IN CANADA
CANADIAN ZURN ENGINEERING, LTD.
2052 St. Catherine St. W.
Montreal 25, Que.

AMERICAN FLEXIBLE COUPLING COMPANY
ERIE, PA., U. S. A.

Please send me further information regarding AMERIGEAR COUPLINGS with the Patented Fully Crowned Tooth Form as described in Catalog No. 501 and Bulletin 1052.

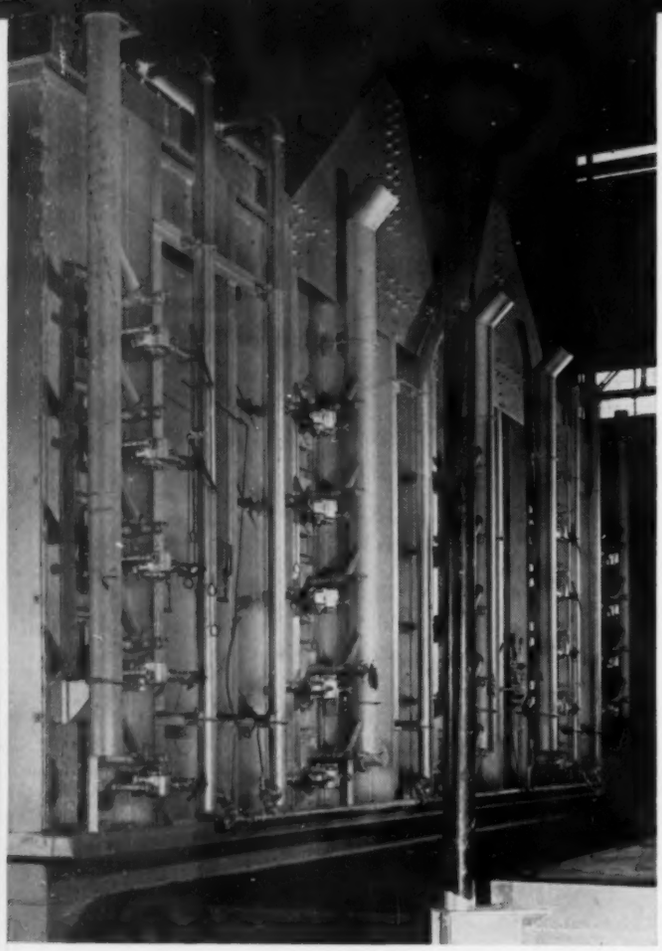
Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

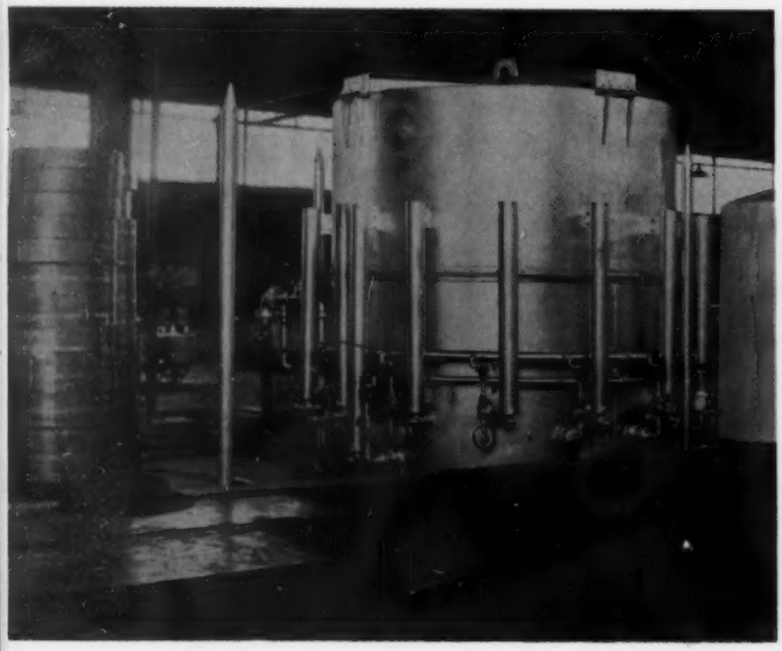
Please attach to your business letterhead.

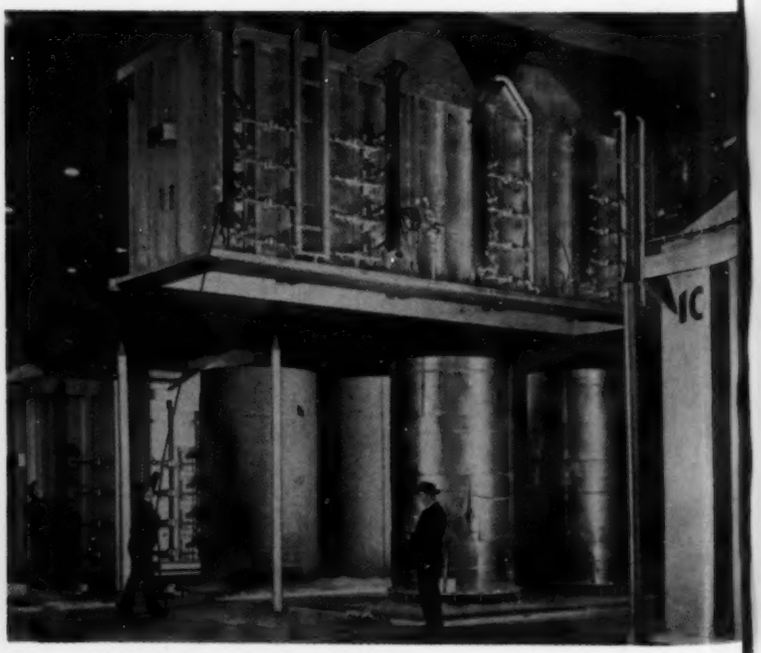


FOR
GENERATIONS
IN
STEEL

The top standard of excellence
in sheet and strip annealing

SWINDELL





INDUSTRIAL FURNACES

Since 1850

In design, construction and performance SWINDELL Annealing Furnaces set the pace in tonnage handling for America's largest sheet and strip producers. • Decade after decade, steady technological advances keep Swindell in the forefront of heating progress—and year after year, long-lived Swindell dependability returns dividends on every furnace investment. • For helpful consultation on your annealing requirements, write us.

SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF INDUSTRIAL FURNACES

PITTSBURGH 30, PENNSYLVANIA

LOEWY ROLLING MILLS

AND ROLLING MILL EQUIPMENT FOR
STEEL, LIGHT METALS, COPPER AND BRASS

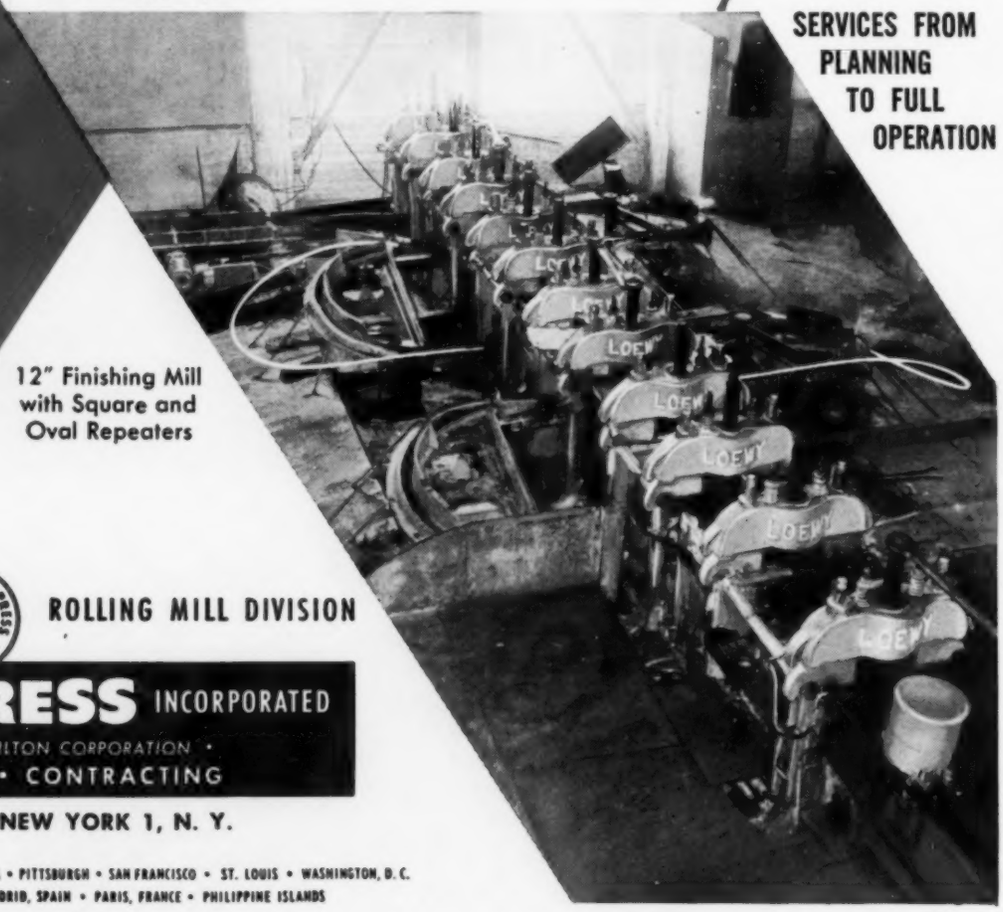
18" Roughing Mill

Continuous Billet and Sheet-Bar Mills • Continuous Merchant and Wire-Rod Mills • Continuous Strip Mills • Skelp Mills • Two-High and Three-High Blooming Mills • Hot and Cold Mills for Non-Ferrous Metals • High-Speed Cold Rolling Strip and Sheet Mills • High-Speed Foil Mills • Special Mills

Parts of a Modern Bar – and Merchant Mill Plant built for the National Shipyard and Steel Corporation, Manila, Philippines.

Complete

SERVICES FROM PLANNING TO FULL OPERATION



12" Finishing Mill with Square and Oval Repeaters

LOEWY — LOEWY-HYDROPRESS NEW YORK N.Y. — **ROLLING MILL DIVISION**

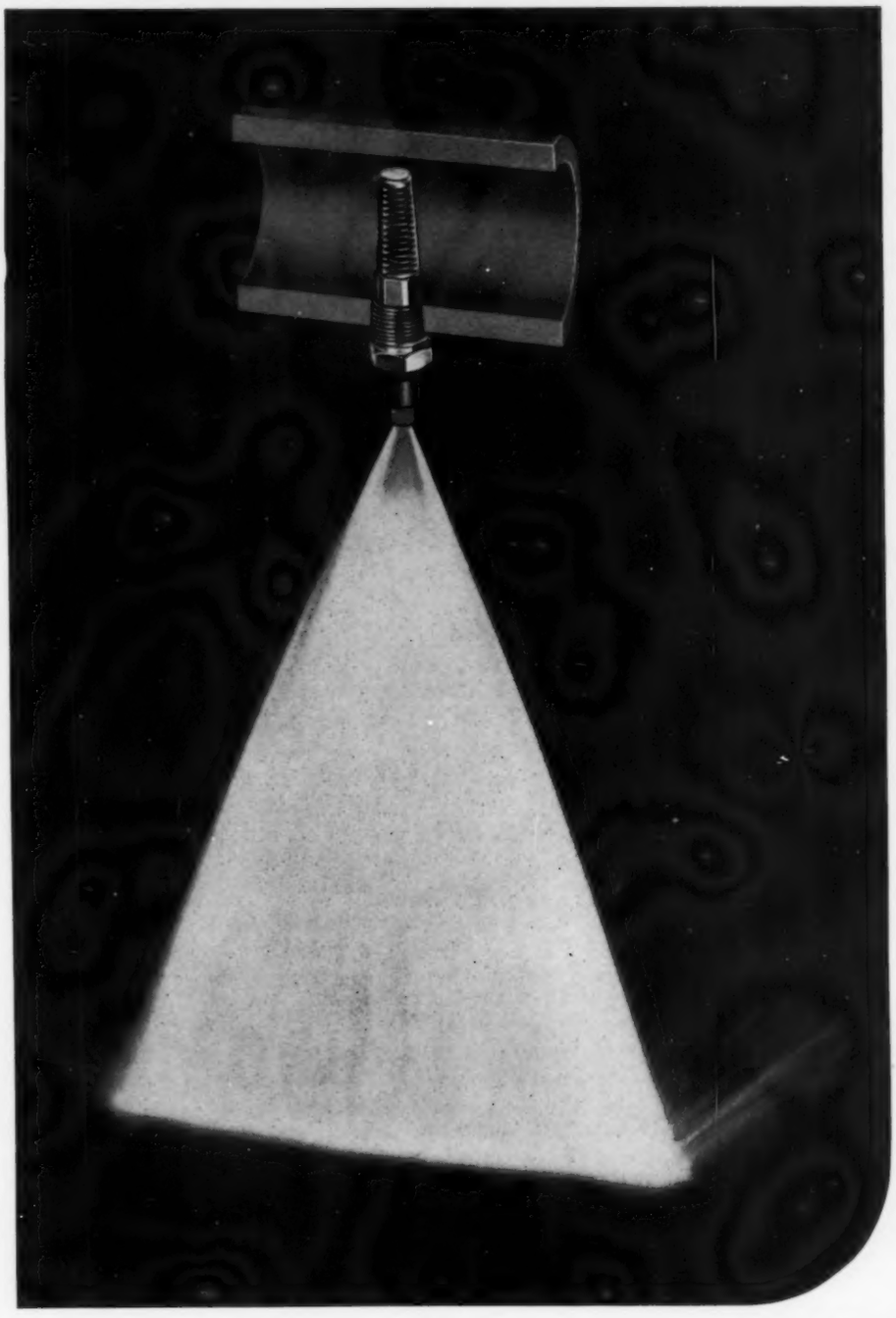
HYDROPRESS INCORPORATED

• BALDWIN-LIMA-HAMILTON CORPORATION •

ENGINEERING • CONTRACTING

350-G Fifth Avenue, NEW YORK 1, N. Y.

CHICAGO • CLEVELAND • LOS ANGELES • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • ST. LOUIS • WASHINGTON, D. C.
GENOA, ITALY • LONDON, ENGLAND • MADRID, SPAIN • PARIS, FRANCE • PHILIPPINE ISLANDS



SPRAYING SYSTEMS

descaling NOZZLES

with open, elliptical non-clogging orifice

for performance *in full measure*

you can SEE the difference

When you consider performance in all its aspects, here are spray nozzles for descaling that give outstanding full measure. Descaling itself is carried out with an efficiency as high as or higher than any other nozzle made. But equally important, Spraying Systems nozzles give you low first cost . . . **plus non-clogging design** that **reduces** the cost of down-time and maintenance to a minimum.

The thin, concentrated, uniform spray strikes with greatest possible impact for any volume and pressure . . . descales without excessive sheet cooling.

Clogging is practically eliminated by *elliptical*-shaped orifice . . . foreign matter goes right through.

CHOICE OF SIZES . . . offered in 16 different capacities . . . for every known descaling use.

Designed and manufactured by America's leading producers of industrial spray nozzles. For complete information write for Data Sheet 6120.

SPRAYING SYSTEMS COMPANY 3262 Randolph Street • Bellwood • Illinois

Spray Nozzles also supplied for such applications as Run-Out Table Cooling . . . Roll Cooling . . . Cooling Ingot Molds and many other uses. For complete information write for Catalog No. 24.

MILL SHUTDOWN ENDED IN 3 HOURS

Shutdown ended when chemical cleaning by Dowell freed stuck valve in 54-inch gas line

Blast furnace dust in this 54-inch gas line caused a butterfly valve to stick open—forcing the shutdown of a steel plant rolling mill. An added complication was that gas flow through the line could not be interrupted. Without lessening the gas flow in the line, Dowell engineers removed the deposits chemically in just *3 hours*—permitting the mill to resume operations.

Here again, quick action by Dowell Service enabled a plant to hold costly outage to a minimum. And many times, as in this instance, Dowell engineers clean equipment without taking it out of service.

Dowell is ready to serve you any time of day or night—bringing all the equipment needed for each job into your plant. Cleaning with Dowell solvents is supplemented, where necessary, by mechanical methods—high-pressure jets and pipe line pigs.

Other steel mill equipment regularly cleaned by Dowell includes blast furnace stoves, gas washers, precipitators, open hearth checkers, boilers and condensers.

Contact the nearest Dowell office to see how Dowell chemical cleaning can help reduce costly shutdowns for you. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, **Dept. K-29.**

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

October 3

▲ The AISI reports that the operating rate of the steel industry for the week of October 3 is scheduled at 96.5 per cent of capacity. This is equivalent to 2,330,000 tons compared with 2,341,000 tons one week ago, and 1,692,000 tons one year ago. Index of production for the week is 145.0.

October 4

▲ Steel output for the first nine months this year reached a total of 85,743,960 tons which topped the previous high for this period in 1953 when the figure was 85,510,617 tons. A record fourth quarter is expected this year which will bring the 1955 total to a record 115,700,000 tons compared with the previous record year of 1953 with a total of 111,600,000 tons.

▲ U. S. Steel Corp. reactivated its No. 7 blast furnace at its Homestead district works in Pittsburgh, Pa. which had been idled for three months for relining.

▲ The Grocery Manufacturers of America said the food industry volume is estimated to reach $66,000,000,000 this year with goals of $83,000,000,000 by 1960 and $96,000,000,000 by 1965.

October 6

▲ Copper dealers cut their quotation by 1½¢ to 48½¢ per lb.

▲ Increasing demands of steel consumers have resulted in an effort by steel producers to increase producing capacities. National Steel Corp. chairman, Mr. Ernest T. Weir, declared that present cost of adding new ingot capacity is around $325 per ton.

October 7

▲ The Aluminum Assn. reported primary production of aluminum in August totaled 267,101,817 lb in comparison with 265,337,163 lb in July and 250,592,575 lb in August 1954.

▲ American and Foreign Power Co. announced it will place orders soon for the construction of atomic power plants in three South American countries.

▲ Price of refined copper was cut 1½¢ per lb by custom smelters to $0.47 per lb.

▲ September employment set a new high for the month but fell below the August record of 65,500,000, according to the Secretary of Labor.

▲ Ford Motor Co. plans a $500,000,000 plant expansion and improvement program in 1957 and 1958 besides the $500,000,000 program planned for 1956.

▲ Dominion Foundries and Steel, Ltd., of Hamilton, Ontario, Canada announced a program for new buildings and equipment totaling $12,000,000. Additions to facilities include another continuous electrolytic tinning line, a cold strip cut-to-length line, a new temper mill and additional coke ovens.

▲ Construction outlays for September totaled a little over $4,000,000,000 which is a record month.

October 10

▲ Shareholders of Copperweld Steel Co. approved the proposal to increase the authorized common stock of the company from 900,000 shares to 1,500,000 shares, to increase the authorized serial preferred shares from 114,605 to 214,605 and to increase the Company's authorized long-term debt to $15,000,000.

▲ The AISI reports that the operating rate of the steel industry for the week of October 10 is scheduled at 97.4 per cent of capacity. This is equivalent to 2,350,000 tons compared with 2,334,000 tons one week ago, and 1,735,000 tons one year ago. Index of production for the week is 146.3.

▲ Copper prices were cut for the third time this month by 1½¢ to $0.45½ per lb.

▲ The Reserve Mining Co. taconite project will begin operations this week.

October 11

▲ Shipments of iron and steel castings during July amounted to 1,243,000 short tons, according to the Bureau of the Census, Dept. of Commerce. This was 19 per cent below June but 31 per cent above the July 1954 shipments.

▲ Unemployment in September dropped to 2,100,000 which was an 88,000 drop from August. This compared with 3,000,000 unemployed in September of the previous year, reported the Commerce and Labor Depts.

October 12

▲ Steel output in September reached a new high with 9,881,000 net tons of ingots and steel for castings compared with 9,594,545 tons in August and 6,807,483 tons in September 1954.

▲ According to the SEC, corporate pension funds held $11,200,000,000 in assets at the close of 1954 in comparison with $6,400,000,000 showing that these funds have tripled in the last three years.

October 14

▲ Custom smelters cut the price for spot copper ½¢ per lb to $0.45 per lb.

▲ Kaiser Steel Corp. resumed operations at its Fontana, Calif. plant following a 16-day strike.

▲ The ODM has diverted to industry 6,000,000 lb of nickel from scheduled shipments to the Government for November and December.

October 15

▲ The Aluminum Assn. reported primary aluminum production in the United States totaled 261,211,002 in September compared with 267,101,817 lb in August and 240,664,643 lb in September 1954.

October 16

▲ The Bureau of Mines, United States Dept. of the Interior reported stocks of ferrous scrap held by consumers on August 31, totaled 6,571,000 gross tons, an increase of 3 per cent over July's 6,367,841 tons. Scrap consumed in August totaled 5,900,000 tons.

October 17

▲ According to the Agriculture Dept., cotton planting quotas were set at 17,300,000 acres for 1956, a cutback of 4 per cent from the 1955 allotments.

▲ Class I railroads settled their wage arguments with the Brotherhood of Locomotive Firemen and Enginemen by granting a 17½¢ hourly package.

▲ Republic Steel Corp. sold two of its Minnesota iron ore mines to Pacific Isle Mining Co. of Hibbing, Minn.

▲ The British Aluminum Co., Ltd. plans to build a $130,000,000 plant at Baie Comeau in Quebec for the production of primary aluminum with an expected capacity of 220,000,000 lb aluminum ingots yearly.

▲ The AISI reports that the operating rate of the steel industry for the week of October 17 is scheduled at 96.1 per cent of capacity. This is equivalent to

2,320,000 tons compared with 2,330,000 tons one week ago, and 1,769,000 tons one year ago. Index of production for the week is 144.4.

▲ Zinc advanced ½¢ a lb to 13½¢ per lb in East St. Louis.

▲ Inland Steel Co. has acquired the Cleveland Steel Barrel Co. by exchanging 18,463 shares of Inland stock.

October 18

▲ Deliveries of new domestic freight cars in September were 3118 compared with 3480 in August and 2566 in September 1954, according to the ARCI. Orders in September totaled 3228 compared with 13,405 in August. Backlog of cars on order as of October 1 stood at 52,913.

October 19

▲ The ICC made permanent the freight rate increases of 12 to 15 per cent which were granted the railroads in 1952.

▲ According to the president's council of economic advisors, national production of goods and services extended its advance during the third quarter by climbing to an annual rate of $392,000,000,000 which is $7,000,000,000 above the previous high in the second quarter.

▲ U. S. Steel plans to expand its facilities at its Youngstown district open hearth plant for producing high grade alloy and forging quality steels by a special ingot making process. A $2,500,000 plant will be erected for this purpose.

October 20

▲ Lukens Steel Co. has increased the price of steel plate $6 to $96 a ton.

▲ Due to increased demands for ferroalloys by the steel and aluminum industries, Vanadium Corp. of America will build a new ferroalloy plant in Jefferson County, Ohio.

▲ Republic Steel Corp. will double its output of plastic pipe by installation of such facilities in its Cleveland pressed steel division plant. Present production is carried on at its plant in Magnolia, Ark.

▲ Republic Steel Corp. has retired the last of its 3 per cent First Mortgage Sinking Fund Bonds due in 1965. The original offer in 1944 was for $50,000,000 and at the end of 1954 this issue amounted to $14,570,000.

October 21

▲ Colorado Fuel and Iron Co. raised price of its carbon steel plates $6 to $96 a ton at Claymont, Del.

▲ Canadian pig iron production was 288,864 tons in August, up 73 per cent. August steel production was 379,878 tons, up 60 per cent.

▲ According to the Commerce Dept.'s Business Advisory Council, economic activity next year is expected to top the 1955 record in home-building and auto output.

October 24

▲ The AISI reports that the operating rate of the steel industry for the week of October 24 is scheduled at 98.2 per cent of capacity. This is equivalent to 2,370,000 tons compared with 2,386,000 tons one week ago, and 1,776,000 tons one year ago. Index of production for the week is 147.5.

▲ According to the Assn. of American Railroads, railroads will spend at least $6,000,000,000 in improvements over the next five years thus making it necessary to increase their net income by 21 per cent to meet this expense.

▲ Strategic Materials Corp. will use about two-thirds of their recent stock sale of 340,000 shares at $10 to build a pilot plant for production of ferromanganese from low grade manganese ores.

▲ Price of zinc was cut ½¢ to $0.13 per lb after an unsuccessful attempt to sell at $0.13½.

October 25

▲ Stockholders of Granite City Steel Co. approved a stock option plan for officers and key employees of the company.

October 26

▲ Industrial Heating Equipment Assn. reports orders received for industrial furnaces for September totaled $8,350,712 in comparison with last September's total of $2,534,335.

▲ U. S. Industries, Inc., formerly the Pressed Steel Car Co., has acquired Southern Pipe and Casing Co., near Azusa, Calif. for $3,715,000 in convertible debentures.

October 27

▲ Resistance Welder Manufacturers' Assn. reported a 36 per cent increase in new orders for the first nine months of 1955 over 1954.

▲ Kaiser Steel Corp. contracted to ship 110,000 gross tons of pig iron to Japan.

▲ The AISC reports September bookings of fabricated structural steel amounted to 339,461 tons compared to 312,338 tons in August and 206,606 tons in September 1954. Shipments in September totaled 289,128 leaving a backlog of work ahead as of September 30 of 1,853,549 tons.

October 31

▲ Machine tool orders for the first nine months of 1955 totaled $579,000,000 or 37½ per cent above the like 1954 period.

▲ Chilean miners walked out in protest against a proposed new Government code regulating relations between the workers and employers. The strike shuts down Chile's three largest copper mines, two owned by Anaconda and one by Kennecott.

▲ General Electric Co. reported third quarter net sales of $722,077,000, net profit of $39,467,000 or $0.45 per common share in comparison with 1954's third quarter sales of $719,800,000, net profit of $42,335,000 or $0.49 per common share.

▲ General Motors' sales for the third quarter of this year totaled $3,031,000,000 with earnings of $0.90 per share, in comparison with $0.59 in the previous year's third quarter.

▲ Westinghouse Electric's third quarter sales fell to $378,000,000, down $23,000,000 from the third quarter of 1954. Net income dropped to $0.84 from $1.04 in last year's quarter.

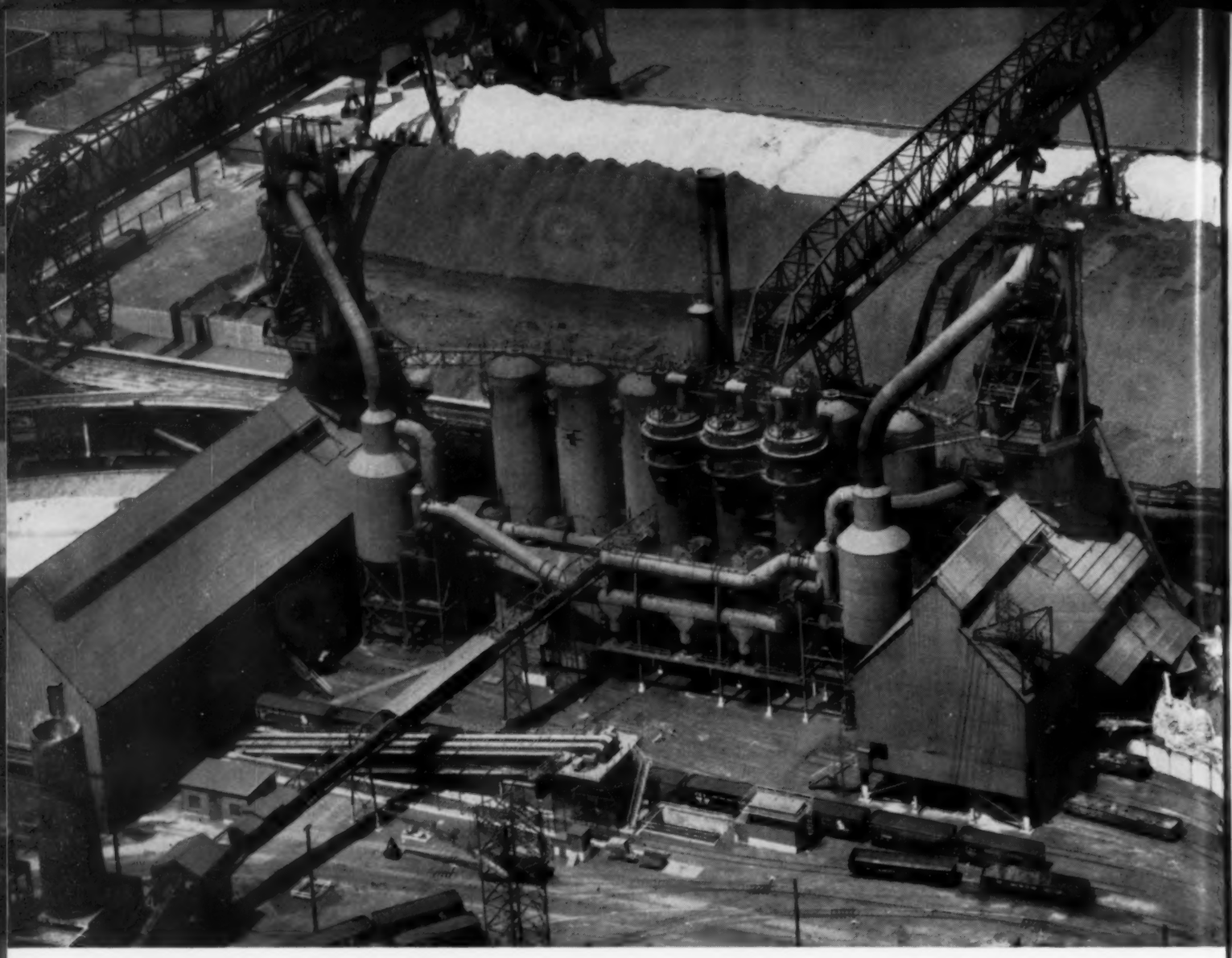
▲ Stockholders of Continental Foundry and Machine Co. approved the sale for cash of its physical assets, inventories and business to Blaw-Knox Co. of Pittsburgh, Pa. and also approved management's proposal for complete liquidation of Continental Foundry and Machine Co. Sales will amount to approximately $19,700,000.

▲ Auto production reached a high level last week with assemblies of 157,716 cars which was 14 per cent above the previous week and 130 per cent above one year ago.

▲ U. S. Steel Corp.'s American Steel and Wire Div. raised price for special finishing of certain sizes of hot rolled wire rods by $1 to $4 per ton.

Steel Company Financial Reports

	Period	1955 Net sales	1955 Net profit	1955 Earnings per share	1954 Net sales	1954 Net profit	1954 Earnings per share
Acme Steel Co.	Third quarter	$ 26,153,631	$ 1,412,783	$0.71			
	First 9 months	79,354,091	4,808,084	2.42	$ 60,484,743	$ 3,043,286	$1.53
Allegheny Ludlum	Third quarter	64,983,067	4,015,512	2.29	38,603,712	546,886	0.27
	First 9 months	181,825,562	10,431,166	5.92	123,888,905	2,438,558	1.29
Armco Steel	Third quarter	179,252,980	17,364,452	1.63	129,399,821	10,167,371	0.98
	First 9 months	508,774,647	45,384,986	4.28	396,470,993	29,168,478	2.80
Barium Steel Corp.	Third quarter	18,748,468	972,487 (Before taxes)		14,401,445	81,314	
	First 9 months	50,621,000	41,031	0.01	39,727,000	—81,234 Loss	—0.03
Bethlehem Steel	Third quarter		40,369,984			25,895,487	
Colorado Fuel and Iron	Third quarter		3,876,841	1.27		1,027,096	0.33
Crucible Steel	Third quarter	57,051,575	2,752,293	1.68	33,834,011	380,632	0.23
	First 9 months	171,881,040	9,037,769	5.51	118,389,962	1,693,027	1.03
Detroit Steel	Third quarter	24,856,391	1,381,058	0.55	11,930,750	—190,938 Loss	
	First 9 months	74,287,185	4,006,222	1.59	37,022,311	—758,681 Loss	
Granite City Steel	Third quarter	30,196,316	3,545,513	1.81	16,132,536	1,061,114	0.51
	First 9 months	85,212,651	9,029,116	4.52	49,543,088	2,419,346	1.08
Inland Steel	Third quarter	166,401,313	13,017,963	2.38	125,221,435	6,875,977	1.37
	First 9 months	481,431,923	36,437,815	6.67	405,287,254	26,293,646	5.25
Interlake Iron	First 9 months	71,201,642	5,869,679	3.01	46,671,274	2,114,577	1.08
Jones and Laughlin	Third quarter	182,390,000	12,267,000	1.89	108,702,000	4,387,000	0.65
	First 9 months	513,681,000	34,835,000	5.40	370,068,000	16,534,000	2.49
Kaiser Steel	Third quarter	39,627,209	2,823,645	0.70	29,977,214	969,401	0.12
	Fiscal year (End June 30)	136,148,919	5,741,236	1.08	128,491,032	7,926,666	1.75
Keystone Steel and Wire	Third quarter	24,420,974	2,158,743	1.15	19,356,813	1,741,741	0.93
National Steel	Third quarter	154,159,739	11,468,806	1.55	111,126,403	6,174,370	0.84
	First 9 months	462,551,990	34,501,677	4.68	362,999,801	19,199,718	2.61
Pittsburgh Coke and Chemical	Third quarter	15,030,000	828,000	0.75	8,834,000	248,000	0.15
	First 9 months	43,013,000	2,478,000	2.26	27,166,000	624,000	0.32
Pittsburgh Steel	Third quarter	64,983,067	2,145,983	1.28	38,603,712	481,437	0.11
	First 9 months		4,720,760	2.63		800,310 (Before Preferred Dividend)	
Republic Steel	Third quarter	301,952,235	22,005,740	1.43	195,616,821	10,302,001	0.68
	First 9 months	872,637,026	63,142,811	4.09	628,226,113	35,093,946	2.32
Sharon Steel	Third quarter	41,827,803	1,776,903	1.61	20,586,428	501,578	0.46
	First 9 months	125,464,254	6,264,905	5.69	68,5590,61	1,145,840	1.04
Superior Steel	Third quarter	8,589,129	371,318	1.19	4,362,565	—54,325 Loss	
	First 9 months	27,378,697	1,210,145	3.83	18,940,700	229,706	0.54
United States Steel	Third quarter	1,035,804,426	89,000,000	1.55	769,632,110	44,323,860	0.72
	First 9 months	3,003,965,411	267,506,943	4.65	2,440,474,499	138,174,974	2.28
Wheeling Steel	Third quarter	64,264,000	4,206,000	2.16	46,600,266	1,912,920	0.84
	First 9 months	183,273,000	10,862,000	5.48	141,542,986	6,295,944	2.85
Youngstown Sheet and Tube	Third quarter	156,624,751	11,240,677	3.33	102,482,025	4,474,003	1.33
	First 9 months	451,036,133	29,247,179	8.66	323,217,033	13,544,697	4.04



From plant site to producing plant . . .

McKEE ASSURES YOU SOUND ENGINEERING OF EVERY DETAIL OF YOUR NEW PROJECT

● McKee brings to your project a fifty-year background of specialized experience in the design and construction of some of the most complex types of production facilities in use today. But, equally important to you, is the high *quality* of McKee engineering—the meticulous care given to every detail—from studies for selection of the site to completion of the plant ready for operation.

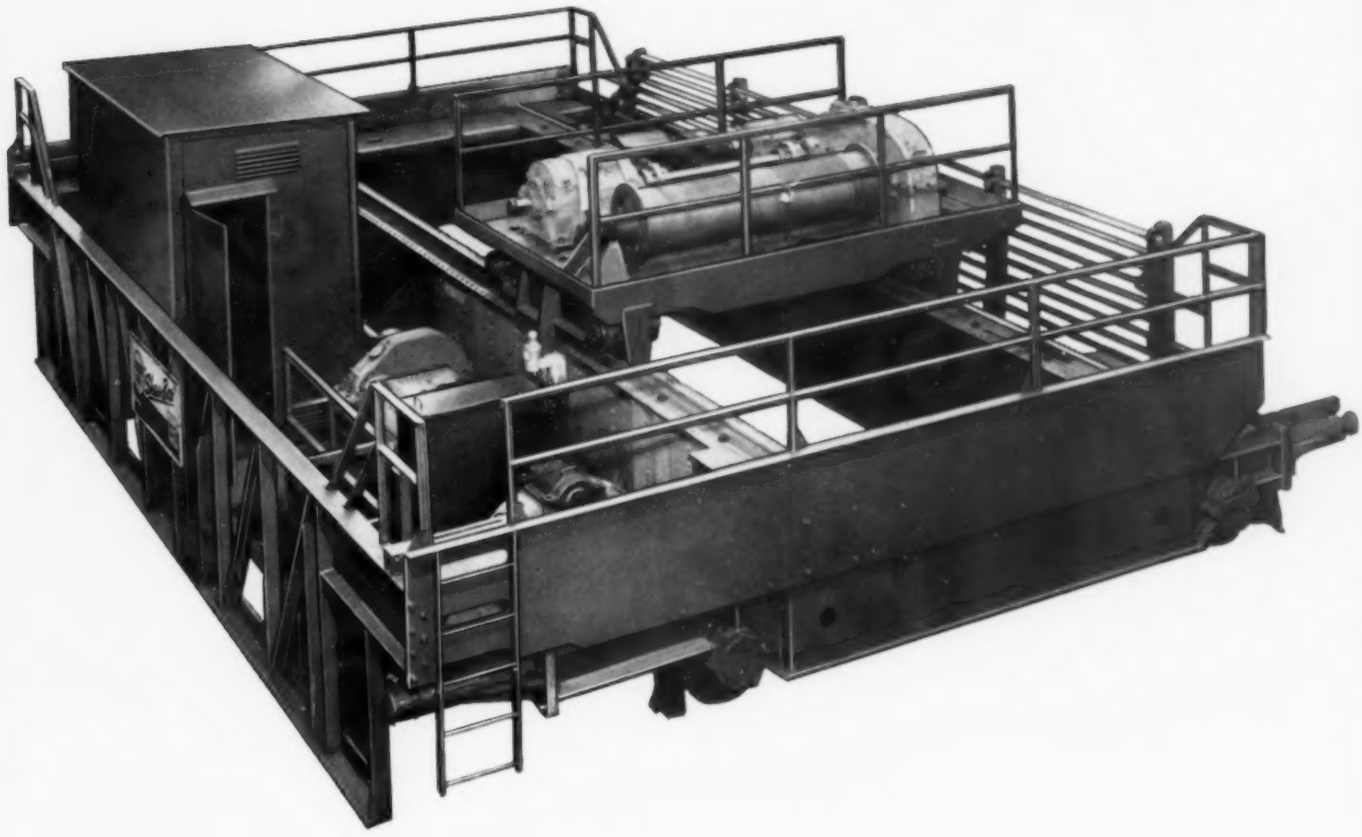
It's this high *quality* of painstaking engineering by McKee that results not only in correct design and efficient layout, but in reduced construction man-hours and most advantageous use of materials. That's why top men in the world-wide industries we serve will tell you "***McKee is the best name you can get***" on the engineering of your new plant.

50th ANNIVERSARY

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto



STEEL MILL CRANES . . . *To A.I.S.E. Spec's*

When you buy "Shaw-Box" Cranes built to A.I.S.E. Standard No. 6 Spec's, you get cranes built exactly to specifications plus the advantages of "Shaw-Box" engineering and manufacturing techniques. You also get the crane performance, maintenance conveniences, and the fine workmanship for which all "Shaw-Box" cranes are famous.

"Shaw-Box" already has standard A.I.S.E. designs for cranes ranging from 15 to 100 tons capacity. So, you pay less for engineering and get more crane for your crane dollars.

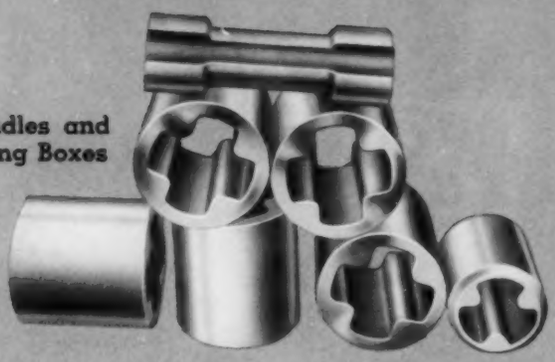
SEND ALL YOUR INQUIRIES FOR CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

MAXWELL MANNING M&M MOORE INC. TRADE MARK

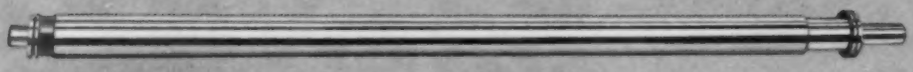
"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.
Muskegon, Michigan

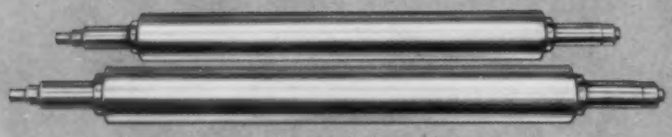
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' and 'American-Microsen' Industrial Instruments, and Aircraft Products.



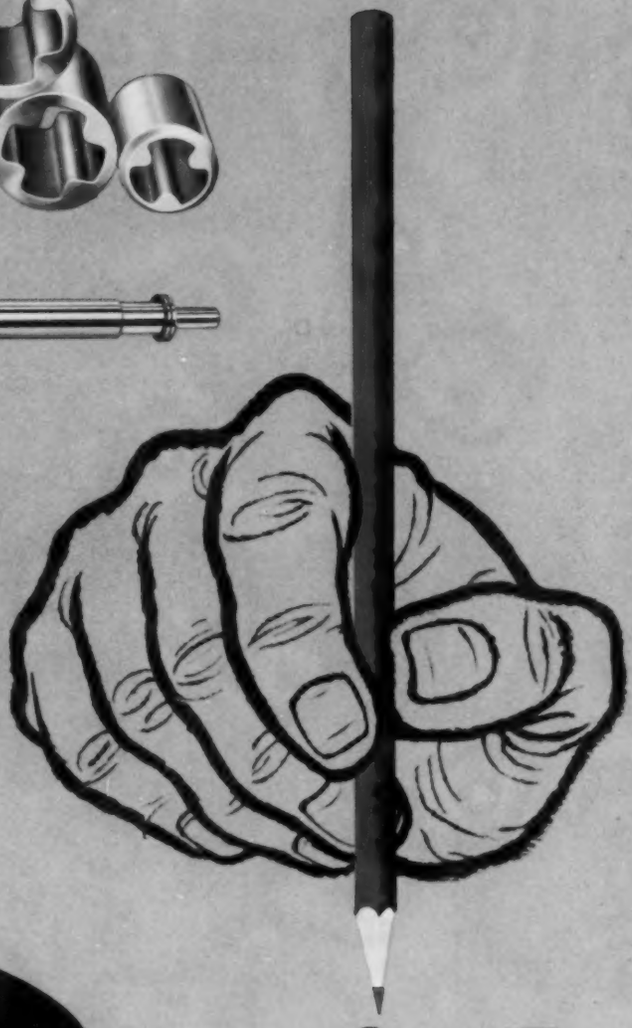
TSP Spindles and Coupling Boxes



Typical Leveller Roll



TSP Pinch Rolls



TSP ... right

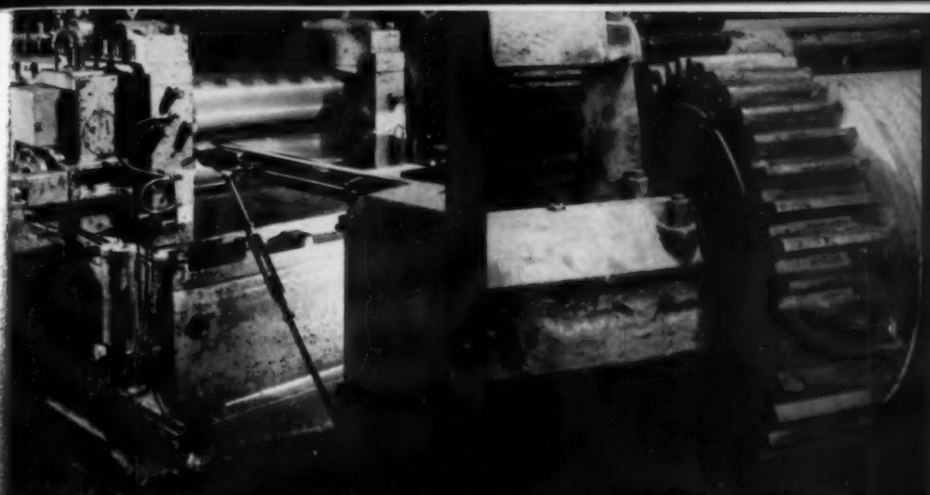
at JONES & LAUGHLIN

ALIQUIPPA WORKS

The records show that "Tool Steel Process" parts play a strategic role in many operations at Jones & Laughlin Steel Corporation's Aliquippa, Pa. Works. Gears, rolls, track wheels, bevel gears and many other parts comprise the long list of TSP products now in use.

TSP products were selected because actual service records in the nation's steel mills prove conclusively Tool Steel's superiority over any competitive material previously used.

All TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum strength. You receive a written guarantee that TSP products will give a longer life in the same service than any other product. TSP products are the standard of quality . . . your best investment.



Hallden Shear in action equipped with TSP racks, pinions, drum gears and rolls.

TSP Pinion and Drum Gear on a 50 ton hot metal crane trolley—Open Hearth Dept.

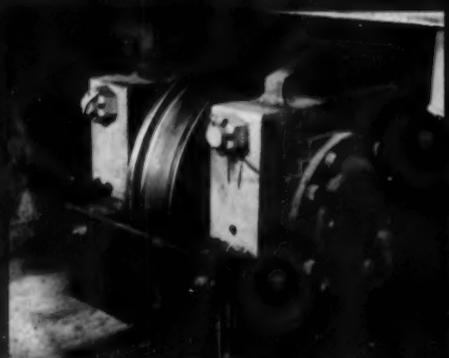
Typical TSP Sheave Wheel

TSP Drum Gears on a Hallden Shear —Tin Plate Dept.

TSP Pressure Rolls on a McKay Processor—Tin Plate Dept.

19" x 43" Temper Mill Rolls

from the records



TSP Travelling Table Wheel on the 30" Round Mill—Seamless Tube Div.

TSP Reel Drive Gear—for Seamless Tube Mill.

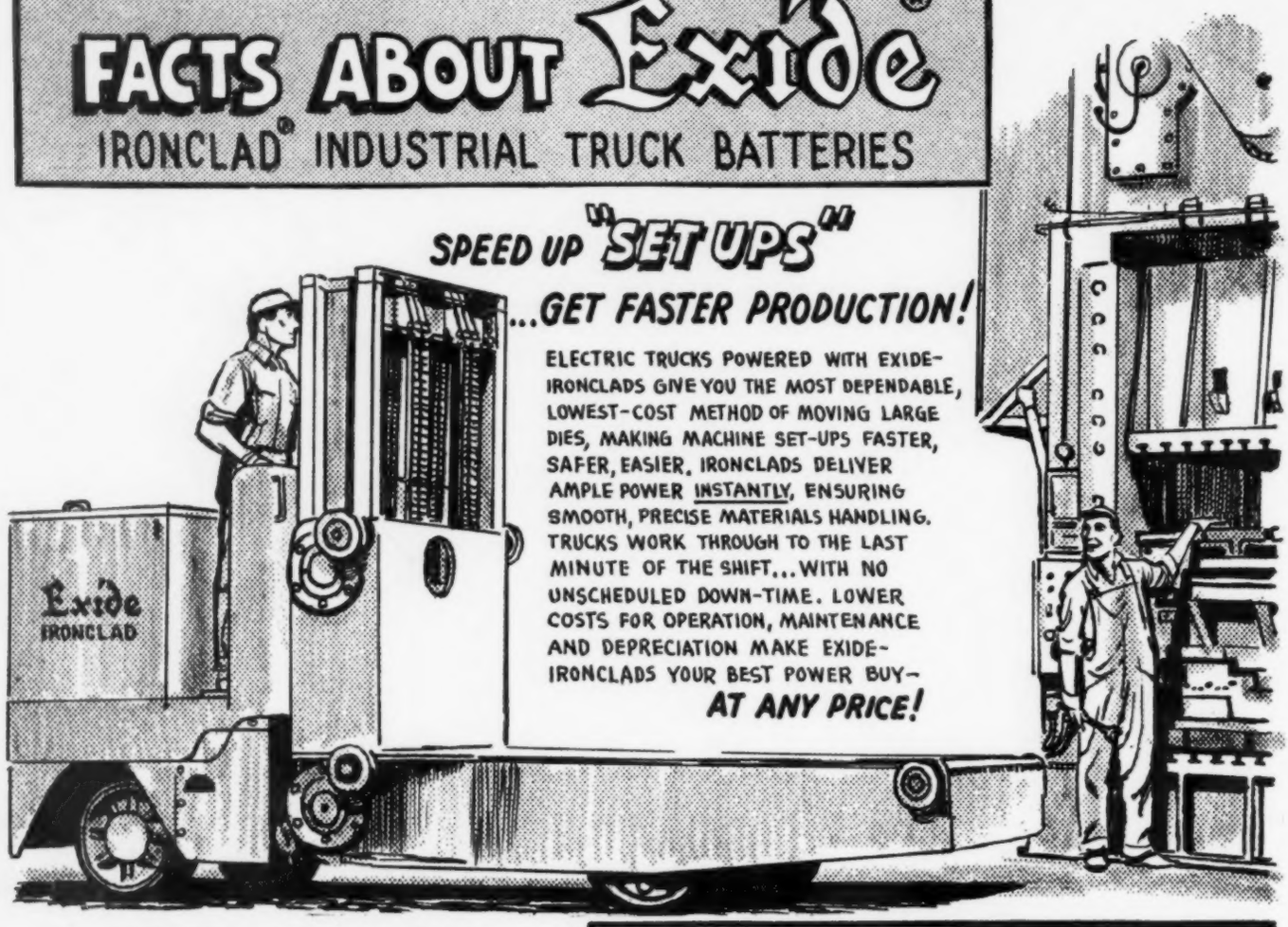
The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

A 5 Stand Tandem Mill with spare rolls in bearing blocks.

THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

AD No. 1015

FACTS ABOUT Exide®
IRONCLAD® INDUSTRIAL TRUCK BATTERIES



SPEED UP "SET UPS" ...GET FASTER PRODUCTION!

ELECTRIC TRUCKS POWERED WITH EXIDE-IRONCLADS GIVE YOU THE MOST DEPENDABLE, LOWEST-COST METHOD OF MOVING LARGE DIES, MAKING MACHINE SET-UPS FASTER, SAFER, EASIER. IRONCLADS DELIVER AMPLE POWER INSTANTLY, ENSURING SMOOTH, PRECISE MATERIALS HANDLING. TRUCKS WORK THROUGH TO THE LAST MINUTE OF THE SHIFT... WITH NO UNSCHEDULED DOWN-TIME. LOWER COSTS FOR OPERATION, MAINTENANCE AND DEPRECIATION MAKE EXIDE-IRONCLADS YOUR BEST POWER BUY— *AT ANY PRICE!*

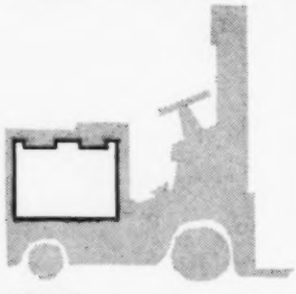
TUBES OF POWER

INSIDE EVERY IRONCLAD ARE SLOTTED TUBES THAT KEEP THE ACTIVE MATERIAL IN FIRM CONTACT WITH CONDUCTING GRIDS OF THE POSITIVE PLATES. THE ELECTROLYTE FLOWS EASILY THROUGH THESE NON-CORRODING SLOTS TO REACH MORE ACTIVE MATERIAL FASTER. RESULT: AN IRONCLAD DELIVERS GREATER POWER... FOR A LONGER TIME... AT LOWEST COST!

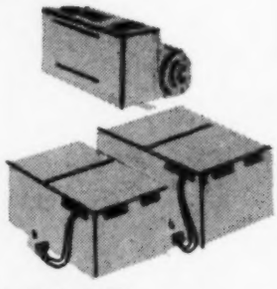
PROTECTED SILVIUM® CONDUCTING GRID
COMPRESSED ACTIVE MATERIAL
SLOTTED POLYETHYLENE RETAINER TUBE

LET EXIDE HELP SOLVE YOUR INDUSTRIAL TRUCK BATTERY PROBLEMS. ❶ CALL AN EXIDE SALES ENGINEER FOR FULL DETAILS. ❷ WRITE FOR FORM 1982, A MANUAL ON INSTALLING AND MAINTAINING MOTIVE POWER BATTERIES.

NOW! CASH OUTLAY FOR ELECTRIC TRUCKS CUT DRASTICALLY BY NEW EXIDE PLAN!



BUY ONLY THE TRUCK CHASSIS! CUT INITIAL CAPITAL OUTLAY AS MUCH AS 33⅓%!



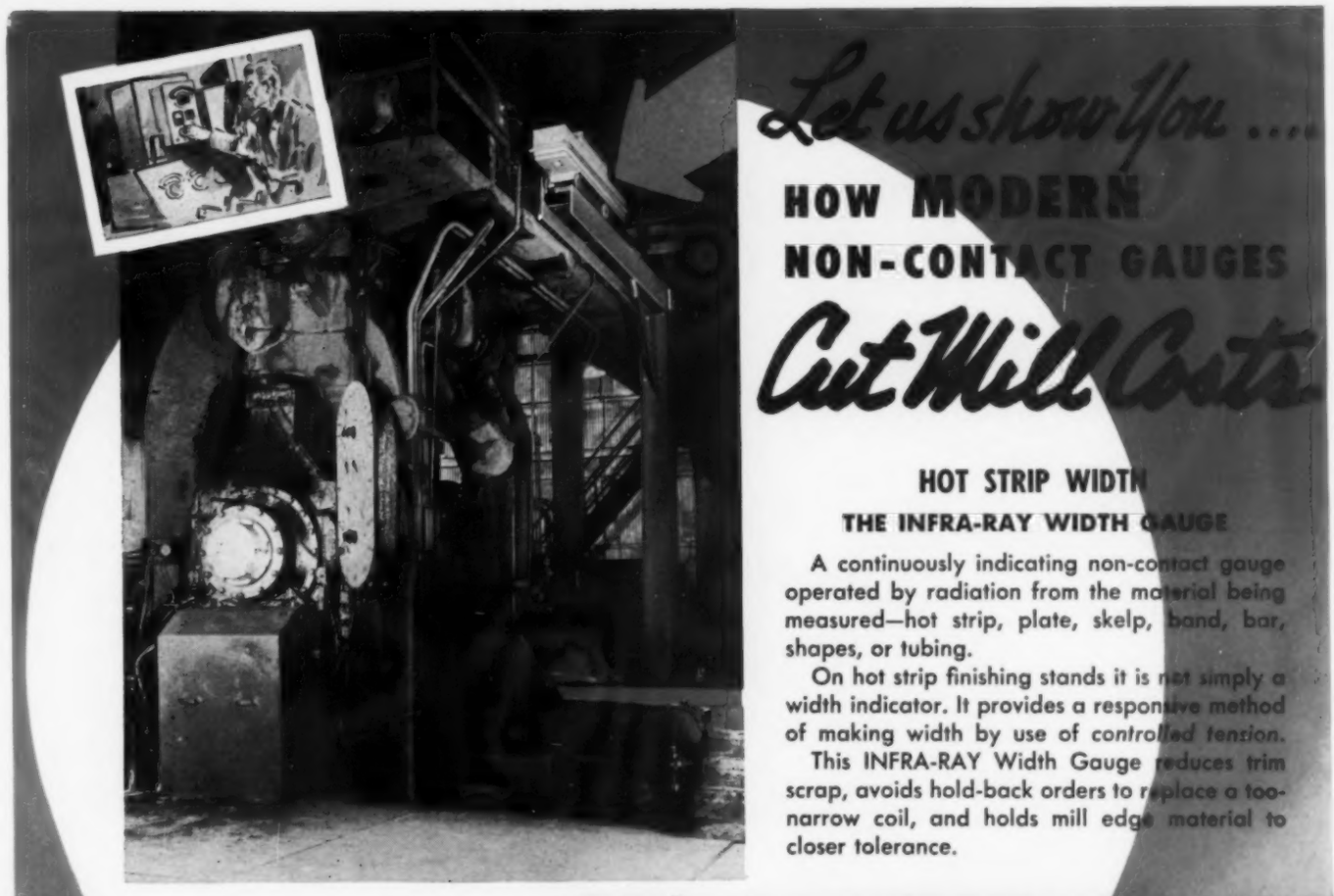
LEASE EXIDE-IRONCLAD BATTERIES AND CHARGER!

IN ADDITION TO THE SUPERIOR OPERATION OF ELECTRIC TRUCKS YOU GET BIG ANNUAL SAVINGS. A TYPICAL EXAMPLE OF HOW MUCH YOU SAVE EACH YEAR WITH ELECTRIC TRUCKS AND THE EXIDE PLAN:

1 TRUCK ON 3-SHIFT OPERATION SAVES $1425.76!

MAKE US PROVE THESE SAVINGS! CALL YOUR EXIDE SALES ENGINEER. ASK YOUR ELECTRIC TRUCK SALESMAN. WRITE FOR COMPLETE DETAILS ON THE EXIDE LEASING PLAN!

Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.



Let us show You ....

HOW MODERN NON-CONTACT GAUGES *Cut Mill Costs*

HOT STRIP WIDTH
THE INFRA-RAY WIDTH GAUGE

A continuously indicating non-contact gauge operated by radiation from the material being measured—hot strip, plate, skelp, band, bar, shapes, or tubing.

On hot strip finishing stands it is not simply a width indicator. It provides a responsive method of making width by use of *controlled tension.*

This INFRA-RAY Width Gauge reduces trim scrap, avoids hold-back orders to replace a too-narrow coil, and holds mill edge material to closer tolerance.

HOT OR COLD STRIP THICKNESS ➡
THE XactRAY THICKNESS GAUGE

An X-ray operated gauge for non-contact, accurate, continuous indication of strip thickness. A trouble-free, non-mechanical, simply-operated thickness gauge that can be adapted to any size or type of rolling mill and mounted close to the rolls.

THE XactRAYMATIC CONTROL

Electronic equipment for automatic strip thickness control — operated by the signal of the X-ray Gauge. Limits thickness deviation of strip from single stand mills or from the first stand of tandem mills by control of roll screw-down motors. Additional equipment can be provided to control thickness automatically by the same means used manually in the remaining stands, with no change of present mill controls.

This XactRAY Thickness Gauge permits you to accept orders with tolerances impossible to meet by hand control, increase speed of rolling, reduce scrap and returned material.

HOT ROLLED ROD DIAMETER
THE INFRA-RAY DIAMETER GAUGE

For continuous measurement of the diameter of hot rolled wire rod as it emerges from the mill. The infra-red radiation of the rod itself supplies the operating signal to the gauge head which is mounted several feet from the rod.

This INFRA-RED Diameter Gauge will not only measure diameter continuously but will also detect lean rod, over-fill, squashouts, and crossed rolls.

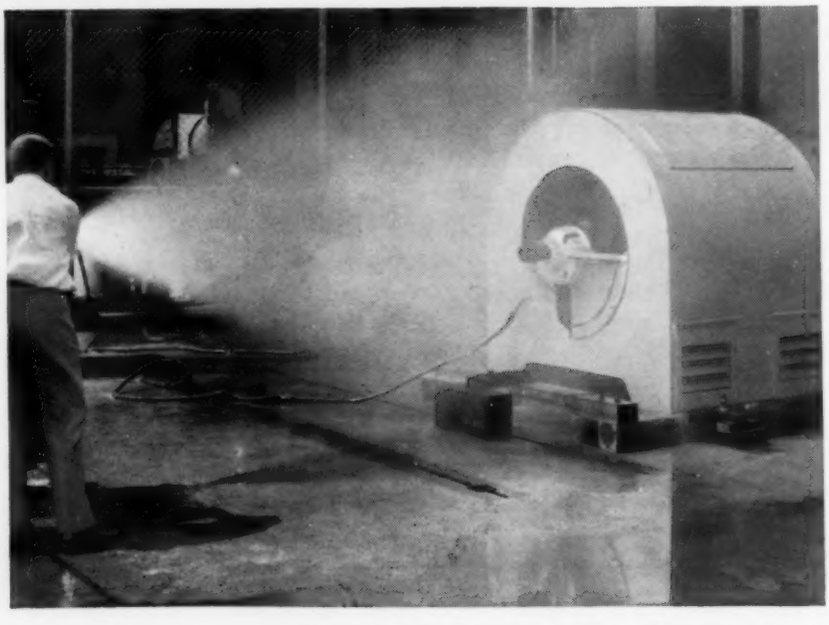
Write for Details

IGC **INDUSTRIAL GAUGES CORPORATION**

ENGLEWOOD, NEW JERSEY

This 800-hp Westinghouse twin-motor drive operates the skin-pass mill work rolls in a 56″ tandem cold mill.

Tests like this prove Thermalastic's superiority. Water can be sprayed into the inlet openings while the motor is running. Immediately following, the coils successfully withstand three times the normal line-to-ground operating voltage.



"Out in the mill" operating conditions don't faze Westinghouse d-c motors

Dust, dirt, moisture, and similar mill atmospheres take a heavy toll of conventional d-c motors. That is why these motors are installed in a separate closed room, where possible. But, often, this is not the most desirable location from an operation standpoint. The best answer is to specify Westinghouse enclosed d-c motors... they are built to operate in most any contaminated atmosphere.

Thermalastic® insulation now available on large d-c motors

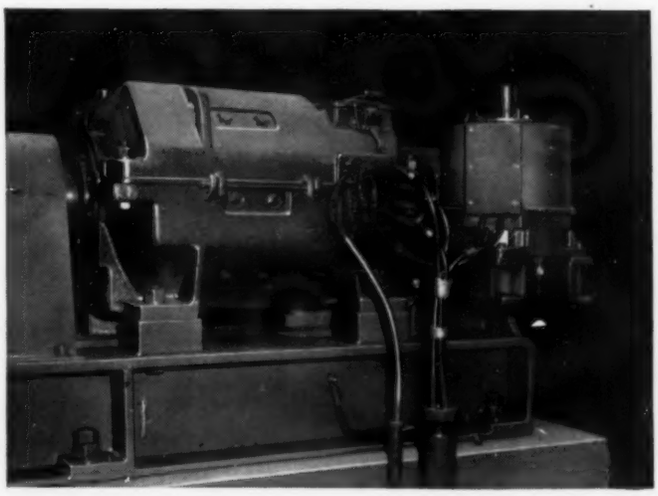
The same Thermalastic insulation that has proved its merit on large Westinghouse a-c motors is now being used on the full line of Westinghouse d-c motors above 250 hp. This is a mica insulation that has characteristics far superior to any ordinary insulation. An impregnating resin is used that is very stable chemically and has high moisture resistance. This, coupled with a high degree of fill achieved in the impregnating process, renders Thermalastic impervious to contamination from foreign elements.

D-c mill motors now provide easy access to brushholders

Whenever you locate a d-c motor in a contaminated atmosphere, you step up the maintenance required on commutator and brushes. That's why the new Westinghouse mill motor is built so that both top and bottom brushholders are accessible through the top openings. Access openings have been added in the lower half of the frame, also.

Ask your Westinghouse Man With The Facts about all the many other plus advantages you get when you install Westinghouse steel mill drives and steel mill auxiliaries. MP-3042

YOU CAN BE SURE... IF IT'S
Westinghouse



This Westinghouse d-c mill motor with SA brake is driving a bar transfer machine in a bar mill. The motor is built to operate regardless of dust and dirt accumulation.

Remove the cover on any frame opening and you have ready access to the commutator and brushholder rigs. Brushholders are quickly removed by loosening the tap bolt.

Choose from 11 types of Ohio Iron and Steel Roll

Carbon Steel Rolls
Ohioloy Rolls
Ohioloy "K" Rolls
Holl-O-Cast Rolls
Chilled Iron Rolls
Denso Iron Rolls
Nickel Grain Rol
Special Iron Roll
Nioloy Rolls
Flintuff Rolls
Ohio Double-Pour Rolls

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • Plants at Lima and Springfield, Ohio

Industry News...

INCREASE IN EXPANSION AND IMPROVEMENT PROGRAM ANNOUNCED BY ARMCO STEEL CORP.

▲ The Board of Directors of Armco Steel Corp. have approved an increase in the 1955 expansion and improvement program from the $60,000,000 announced earlier this year to $111,000,000.

In addition to rounding out the company's processing and finishing facilities, this program will add 1,176,000 tons to Armco's present 4,950,000 capacity, and will result in a capacity of 6,126,000 tons early in 1957 — an increase of nearly 25 per cent.

According to W. W. Sebald, president, almost all of Armco's plants will share in the expansion program. Additions and improvements will be made at Middletown and Zanesville, Ohio; Butler, Pa.; Ashland, Ky.; the three plants of Armco's Sheffield Division at Kansas City, Houston, and Tulsa; the company's W. Va. coal mining facilities; and certain plants of the subsidiaries, Armco Drainage & Metal Products, Inc., and Armco International Corp.

Mr. Sebald said that 60 per cent of the increase in steel melting capacity will be centered at Middletown, where the company's largest plant is located. The remaining 40 per cent will be spread among Sheffield Division plants at Houston, Tulsa, and Kansas City.

Armco's pig iron production will be substantially increased through improvements to present blast furnaces and by use of raw materials with high iron content.

The company's blast furnace at Houston will be enlarged to increase its daily iron output from 1000 tons to 1400 tons.

While a relatively large portion of the $111,000,000 will be expended for increased steel capacity, major additions and improvements will also be made to Armco's rolling and finishing facilities. This part of the program includes an entirely new strip mill at Butler, Pa., rebuilding of a railroad car wheel works there, a third continuous line for coating steel coils with zinc at Middletown, and additions to several plants of Armco Drainage & Metal Products, Inc.

A number of cold finishing mills, pickling lines, annealing furnaces, and wire aluminizing facilities will be constructed or enlarged, and ore blending and sintering facilities will be installed. In addition, several existing rolling mills will be revamped to increase their capacity and efficiency.

Although not part of this program, a new rod mill for rolling stainless steel is nearing completion at Armco's Baltimore Works.

AWARDS COKE OVEN CONTRACT TO KOPPERS

▲ A contract for the design and construction of three batteries of by-product coke ovens, totalling 192 ovens, and auxiliary equipment at U. S. Steel Corp.'s Clairton Works has been awarded to Wilputte Coke Oven Division, Allied Chemical & Dye Corp.

This is in addition to three batteries of by-product coke ovens, also totalling 192 ovens, with auxiliary equipment, which Wilputte is now completing at this plant.

NEW CONTINUOUS LINE SET FOR IRVIN WORKS

▲ A complete new line for the production of U.S.S. Vitrenamel sheets and other special sheet products will be installed at U. S. Steel's Irvin Works.

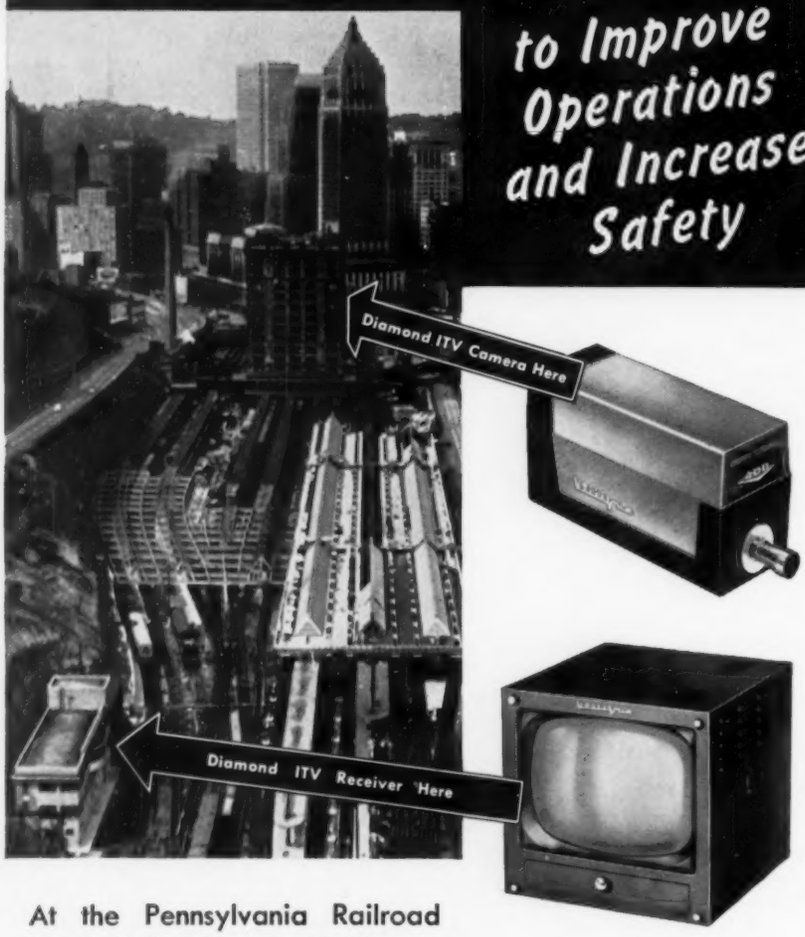
First phase of the expansion will be the erection of a new building 600 ft long and 80 ft wide to house the continuous line and auxiliary equipment. The continuous line will have two uncoilers, continuous welding equipment, a gas fired heating furnace, a pickling line, scrubbing and drying facilities, a recoiling unit and shearing facilities.

This new equipment will be used primarily for the production of U.S.S. Vitrenamel sheets. It is also capable

NEW MIDDLETOWN FURNACES UNDER CONSTRUCTION

Three open hearth furnaces, to be added to the present No. 2 open hearth shop at Armco Steel Corp.'s Middletown, Ohio plant, are well on their way to completion. Richard Deebe, left, of McGraw Construction Co., which is building the new facilities, and Armco engineer, Neal Kurfiss, are shown looking over the new construction. Two of the new open hearths are expected to be operating by Spring, the third by the end of 1956.

PENNSYLVANIA RAILROAD *uses* DIAMOND INDUSTRIAL TV *to Improve Operations and Increase Safety*



At the Pennsylvania Railroad terminal building in Pittsburgh, Diamond ITV watches the movement of mail cars in and out of the Post Office. The image is transmitted to the train director in a control tower 2000 feet away and on the other side of the terminal.

You, too, probably can use Diamond ITV to substantial advantage. For case histories and suggestions, get in touch with your Graybar Distributor or use the coupon below.

7259

Distributed by Graybar Electric Company

DIAMOND POWER SPECIALTY CORP.
"FIRST IN INDUSTRIAL TELEVISION"
ELECTRONICS DEPT., P.O. BOX 415 LL
LANCASTER, OHIO

Please send me without obligation a copy of new bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs, improve quality, increase sales and aid safety.

Name_____

Title_____

Company_____

Address_____

of producing heat treated sheet products in carbon, alloy and stainless grades for national defense purposes. The product will be supplied in both coils and sheets.

Ground will be broken about December 1, with completion of the new facilities scheduled for late in 1956.

CARPENTER ANNOUNCES FIVE-YEAR PROGRAM

▲ A five-year expansion program was announced by the Carpenter Steel Co. to their stockholders in the company's 1955 fiscal annual report.

Sharing in the five-year blueprint are the firm's Alloy Tube Division, Union, N. J., and Webb Wire Division, New Brunswick, N. J. Commitments for new plant and equipment already totaled $1,700,000 by the end of the fiscal year, June 30, 1955, and an investment of at least $9,000,000 will be involved in expansion and modernization during the 1955-60 period.

The 1956 part of the program includes installation of a large hydraulic forging press and an additional arc-melting furnace. The press will increase Carpenter's capacity for the manufacture of high temperature alloys and larger size forgings. Addition of the furnace is expected to increase the company's melting capacity by 20 per cent. Both are on order for delivery early next year.

Also contemplated is a high speed bar turning machine, additional heat treating facilities, modern handling equipment and other items designed primarily to increase productivity.

New equipment already installed under the present five-year plan includes the latest type of non-destructive electronic tube testing equipment for maintaining high product quality, and a modern controlled-atmosphere furnace for annealing stainless steel wire.

PURCHASES MEXICAN REFRACTORIES FIRM

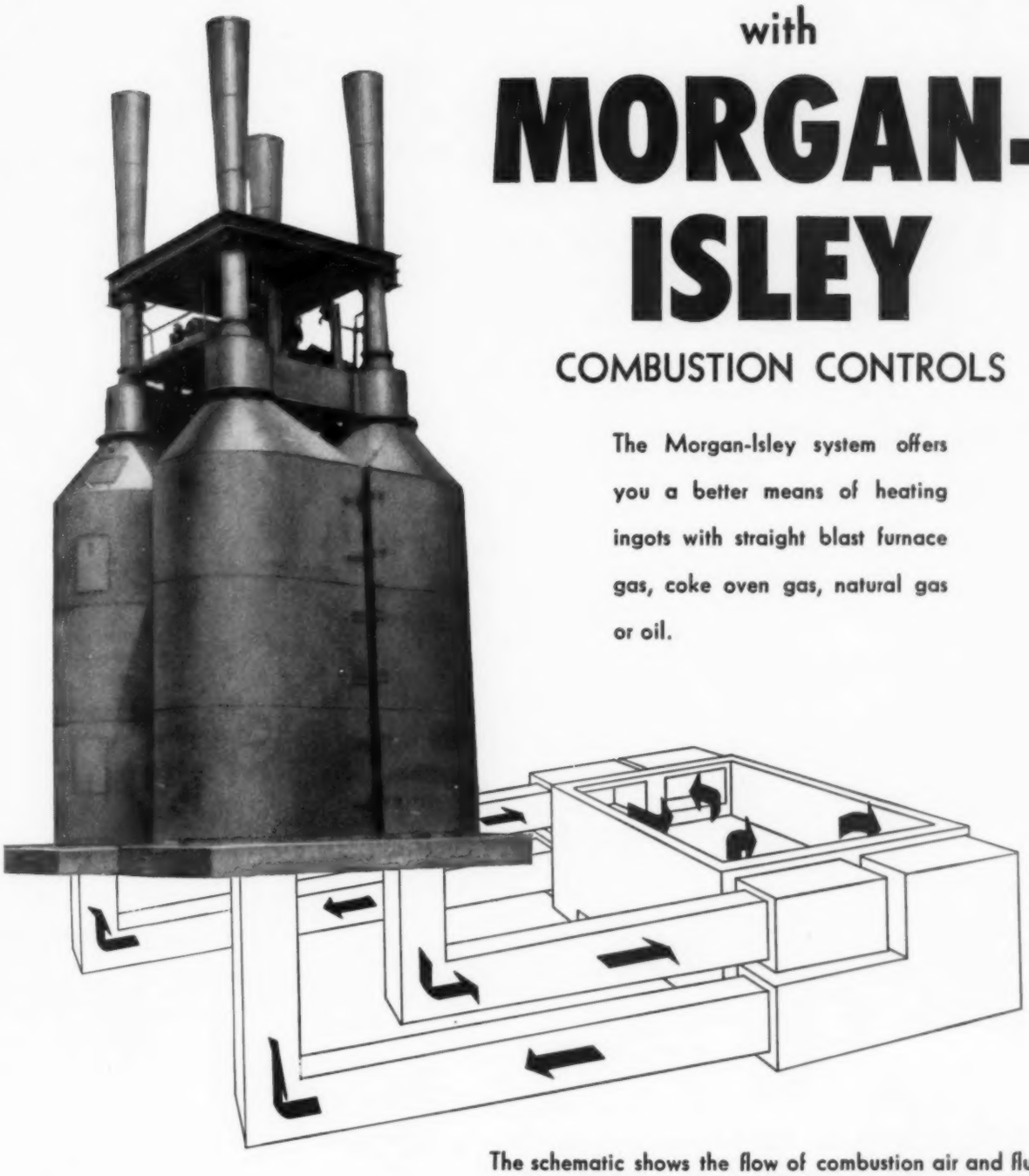
▲ Harbison-Walker Refractories Co. announced the purchase of an interest in Fabrica de Ladrillos Industriales y Refractarios, S. A., (Flir) of Mexico. The firm is a subsidiary of Cia. Fundidora de Fierro y Acero de Monterrey, S. A. It is planned to change the name to Harbison-Walker-Flir, S. A.

High Fuel Savings

with

MORGAN-ISLEY

COMBUSTION CONTROLS



The Morgan-Isley system offers you a better means of heating ingots with straight blast furnace gas, coke oven gas, natural gas or oil.

The schematic shows the flow of combustion air and flue gases through the regenerators and soaking pit. The Morgan-Isley system employs vertical regenerators. It eliminates regenerator capacity under the crane runway thus freeing this valuable area for heating steel.

CCC-8

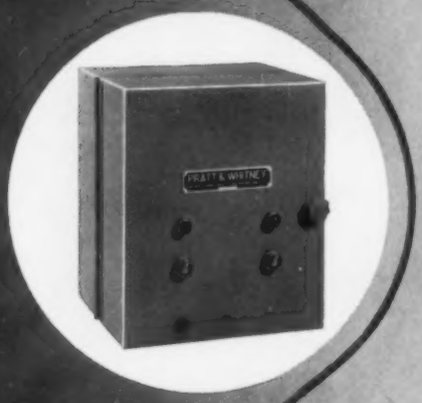
MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

ROLLING MILLS • MORGOIL BEARINGS • REGENERATIVE FURNACE CONTROLS • EJECTORS • PRODUCER GAS MACHINES

H. H. Wood, Rep., Koppers Bldg., Pittsburgh, Pa. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, Eng.

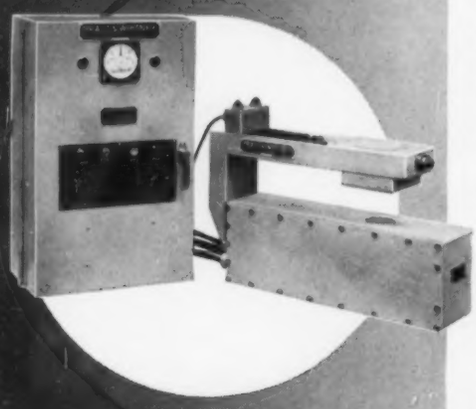
Only PRATT & WHITNEY

manufactures all the types of GAGES and AUTOMATIC CONTROLS for the Steel Industry



AUTOMATIC SCREWDOWN CONTROLS

. . . now on the job in more than 20 mill installations. Provide fully automatic control of strip thickness.



NON-CONTACTING GAGES

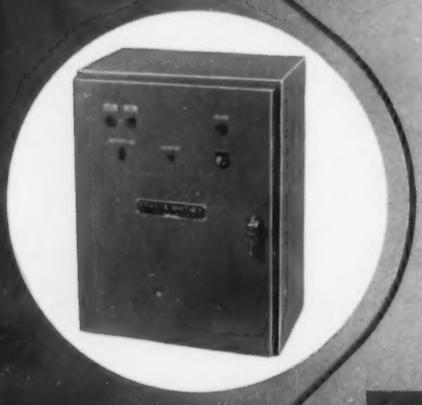
. . . continuously indicate and record thickness or weight deviations in strip or sheet steel, tin plate, brass, aluminum etc., without touching the material.

X-RAY GAGES

. . . gage a wide variety of sheet and strip materials. Simple to install and maintain. Stability is excellent, unaffected by voltage fluctuations.

CONTACT GAGES

. . . Model D Continuous Gages coupled with P&W Automatic Controls can be arranged to operate warning lights, audible signals and shut-off devices, as well as automatic controls.



AUTOMATIC TENSION and SPEED CONTROLS

. . . provide continuous and complete feed-back control for applications where a vernier on the screwdown is required.

WRITE FOR GAGE LITERATURE

Pratt & Whitney Company, Incorporated
Charter Oak Boulevard
West Hartford, Conn.

KEEP QUALITY UNDER CONTROL WITH PRATT & WHITNEY CONTINUOUS GAGES AND AUTOMATIC CONTROLS

The firm produces fireclay and silica refractories in a modern plant at Monterrey, Mexico, and is expected to supply a substantial share of the refractories requirements of Mexican industry. Mexican personnel will continue to operate the plant now being enlarged, but in the future Harbison-Walker will supply technical management.

YS&T AWARDS CONTRACT TO AETNA-STANDARD

▲ A contract for the design, construction and installation of a new seamless tube mill was awarded to the Aetna-Standard Engineering Co. by the Youngstown Sheet and Tube Co.

This mill, to be located at the Company's Indiana Harbor Works, will produce seamless tubes in sizes from 4½ in. diameter to 9⅝ in. diameter.

In addition, Aetna-Standard also has been awarded contracts to furnish a continuous annealing line for Dominion Foundries & Steel Co. of Hamilton, Ontario, Canada; a tube sizing mill for Timken Roller Bearing Co., and a piercing mill, and drawbench equipment for copper tubing for the Los Angeles plant of the American Brass Co.

Also announced is an order from Jojalata, Y. Lamina, S.A. Monterrey N.L. Mexico for a sheet shearing line and a hot dip tinning line.

SQUARE D CO. FORMS ENGLISH SUBSIDIARY

▲ An English subsidiary to manufacture and market electrical distribution and control products in the British Isles and Europe has been formed by Square D Co.

The new company, Square D Limited, began operations on Nov. 1, with headquarters at 100 Aldersgate St., London. Plans are underway to set up sales branches in the vicinities of Birmingham and Manchester, England, and Glasgow, Scotland, as the nucleus of a marketing organization which will eventually cover selected export markets as well as important provincial centers in the United Kingdom.

Manufacture of selected motor controls will be subcontracted, initially to Plessey Co., Ltd., a major British electronics manufacturer, and extensive tooling has begun at their plant

in Swindon, England. Meanwhile, components for assembly abroad will be exported by Square D's Industrial Controller Div., Milwaukee, Wisc.

Agreement has been reached by Inland Steel Co. and the Cleveland Steel Barrel Co. on terms of a contract under which Inland would purchase the Ohio firm, subject to clearance by the appropriate government agencies, for 18,463 shares of Inland Stock.

The principal plant of the barrel and pail manufacturer in the city of Cleveland, and a smaller plant in Greenville, Ohio, will be merged into the operations of Inland Steel Container Co. when the purchase is completed. The acquisition would represent a 20 per cent expansion of Inland's container division.

L. B. Hunter, president of the container division, said the addition would broaden Inland's product line by the addition of barrels of heavier gauge than now produced and stainless steel barrels and pails.

ACQUIRES DE LAVAL MILL LUBRICATION DEPARTMENT

▲ Acquisition of the Mill Lubrication Department of the DeLaval Separator Co., Poughkeepsie, N. Y., has been announced by the Dravo Corp.

The DeLaval operations, headquartered in Pittsburgh, will become a part of the Machinery Division of Dravo. The transfer was announced jointly by John K. Beidler, vice president of Dravo in charge of the Machinery Division, and W. A. McGill, vice president in charge of sales for DeLaval.

Dravo's new Lubrication Section will offer complete design engineering and installation services to the steel, non-ferrous, rubber, paper and other industries requiring specialized lubrication systems.

This new activity will complement the company's present services on mechanical construction, piping, pumps and other mill equipment.

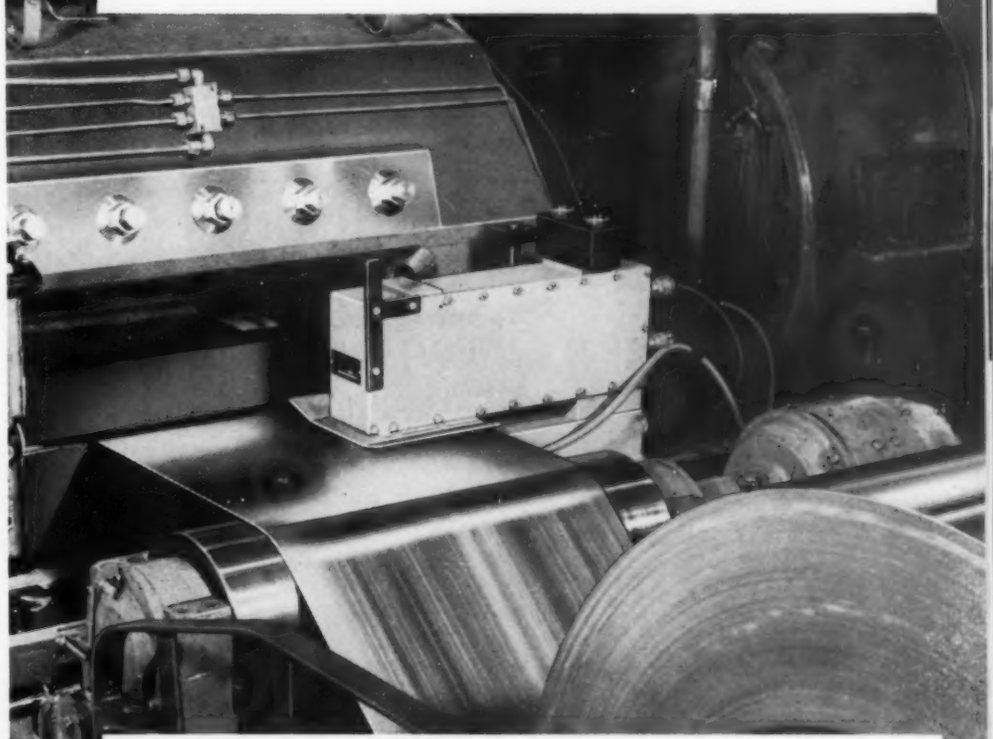
EXPANSION TO INCREASE PRODUCTION 25 PER CENT

▲ Completion in early 1956 of a $750,000 expansion program will increase production capacity of the McKay Machine Co. by 25 per cent.

The Youngstown firm is constructing a 50 by 150 ft addition to Plant One which will add 7500 sq ft to ma-

STRIP MILL PRODUCTION *rolls ahead with* PRATT & WHITNEY Continuous Gages

ORIGINATORS OF THE "FLYING MIKE" IN 1930, P&W CONTINUES TO CONTRIBUTE IMPORTANTLY TO MODERN DEMANDS FOR FASTER SPEEDS, HIGHER QUALITY AND LOWER COSTS THROUGH IN-PROCESS GAGING OF STRIP AND AUTOMATIC CONTROL OF THE MILL



Take advantage of Pratt & Whitney's many years of experience in the design, manufacture and successful application of mill gages; a P&W Engineer is available to analyze your gaging problems, recommend the *right* equipment, and provide expert application engineering service. Complete, integrated, packaged systems — gages, controls and all other components — for fully automatic process control are available. Write today outlining your requirements.

PRATT & WHITNEY COMPANY
INCORPORATED
28 Charter Oak Boulevard, West Hartford 1, Connecticut
Branch Offices and Engineers in Principal Cities
MACHINE TOOLS • GAGES • CUTTING TOOLS

You Can Be Sure of

STRONGER BLAST FURNACE LININGS

after you apply

SUPER #3000 Refractory Bonding Cement

Plants Report—

- Super #3000, with but one-tenth the percentage of iron contained in other refractory bonding mortars, shows exceptional resistance to attack by carbon deposition and alkalis on blast furnace stack linings.
- Super #3000 is volume stable, expanding and contracting with the brick; hence it does not shrink or crack in the joints.
- Super #3000, with its heavy body and water retention properties, makes tight joints that prevent passage of gases into the wall. Used as a wash coat, it reduces oxidation.
- In the hearth, bosh and stack, Super #3000 has proved conclusively to be the strongest, most abrasion-resistant and spall-proof of all high temperature bonding mortars.
- Super #3000 reduces maintenance cost for materials, labor and outage, and increases blast furnace productivity.

Super #3000 Refractory Cement challenges comparison and investigation. Write for details.

REFRACTORY & INSULATION CORP.

R&D

REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET • NEW YORK 5, N. Y.

chine shop facilities there. It is the sixth addition to the building, and the company's major expansion since World War II.

A 20,000 sq ft building on Youngstown's East Side will be used as a fabricating and sub-assembly shop. To be called the Haselton plant, the expansion will enable enlargement of final assembly operations in the main assembly building and permit expansion of the fabricating and sub-assembly facilities.

BEGIN OPERATIONS AT E. W. DAVIS WORKS

▲ Reserve Mining Co.'s huge E. W. Davis Works began initial operations during the week of October 10.

When completed, the plant will have an annual capacity of 3,375,000 long tons of iron ore pellets. The output will be shipped to blast furnaces at steel plants of Republic Steel Corp. and Armco Steel Corp., joint owners of the $190,000,000 taconite project.

CONTRACT AWARDED TO GAS MACHINERY CO.

▲ Sharon Steel Corp. has awarded a contract to the Gas Machinery Co. for the installation of a continuous strip annealing furnace for the company's Detroit Tube and Steel Division, Detroit, Mich.

U. S. GRAPHITE ANNOUNCES EXPANSION PROGRAM

▲ The United States Graphite Division of the Wickes Corp. has announced a $600,000 expansion program. Construction will begin late this year.

The move includes a $500,000 addition to the plant's carbon-finishing department, a $100,000 two-story addition to the firm's office building, and a new loading dock.

KOPPERS CO. PURCHASES TURNER & HAWS ASSETS

▲ All assets of Turner & Haws Engineering Co., Inc. of West Roxbury, Mass., makers of a special line of filters for cleaning industrial air or gas have been purchased by Koppers Co., Inc.

Operation of the newly acquired business will be under Koppers Metal Products Division at Baltimore, Md. This Division has developed a line of

AT
JONES & LAUGHLIN,
Aliquippa,

the electrical installation

of the multiple strand rod mill

and No. 3 electrolytic

cleaning and electrolytic

tinning lines

was executed by

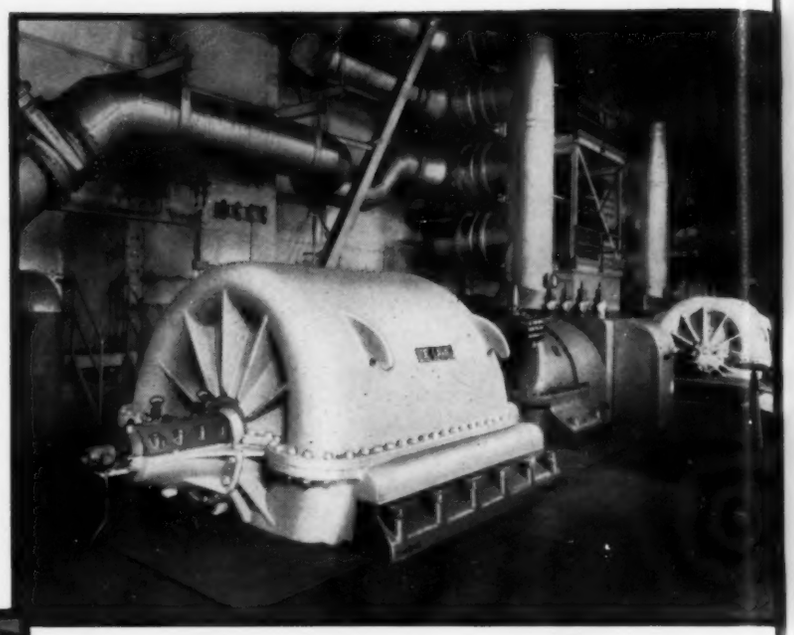
THE DINGLE-CLARK COMPANY
ELECTRICAL CONTRACTORS
PITTSBURGH • CLEVELAND • PHILADELPHIA

DE LAVAL
CENTRIFUGAL BLOWERS AND PUMPS

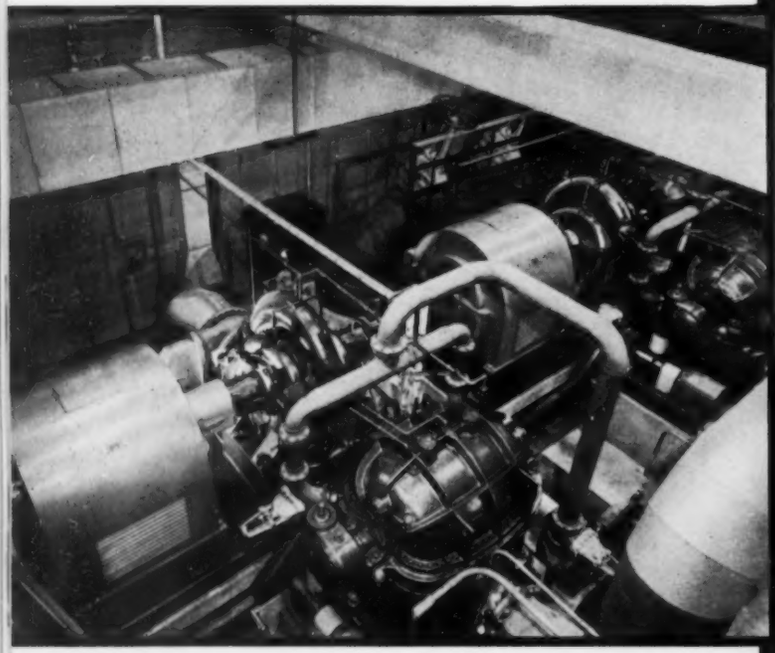
stay on the line for years at Jones & Laughlin

Jones & Laughlin reports: "*We have been using De Laval equipment for many years, and from our experience we have learned that De Laval blowers and pumps are inexpensive to maintain. Service is excellent. We can get spare parts quickly.*"

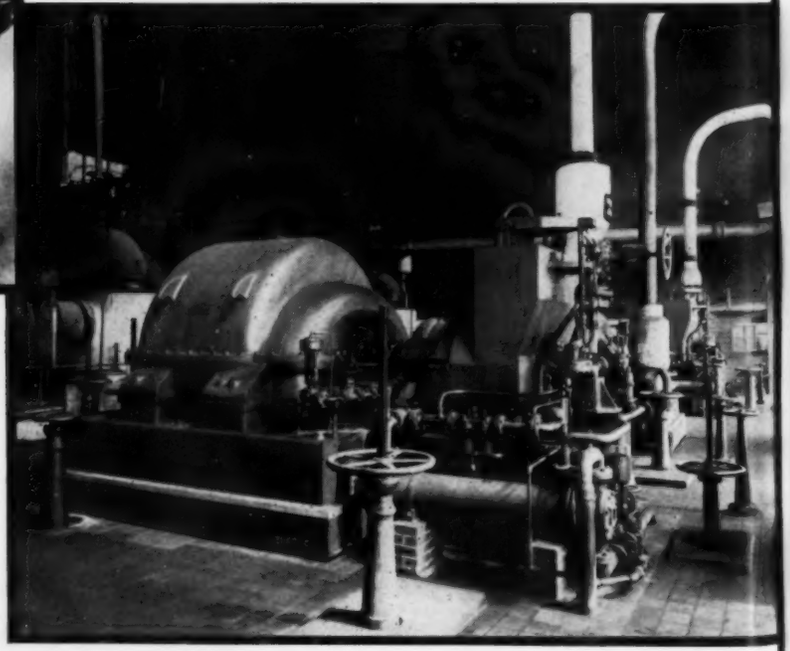
Three De Laval 22,000 gpm motor-driven pumps are on the job at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. These units are used to pump river water to the open hearth and general mill. Installed in October 1951, these three pumps "have not had any downtime at all since their installation except for periodic inspections," Jones & Laughlin reports.



▲ These two De Laval centrifugal blowers, each rated at 100,000 cfm, are in use 24 hours per day, seven days per week except for a yearly inspection period. Since installation, there has been only 24 hours downtime in one of these blowers with a maintenance cost of about $400. "That's very little for this type of equipment," says the Jones & Laughlin blower room foreman.



This is one of three De Laval gas exhausters, operating at 48,000 cfm around the clock. Two of these units can handle maximum capacity; the third is used as a spare. Jones & Laughlin says, "Without good gas exhausters you would have to 'bee hive' (open the top and permit the gas to go free), thus losing our by-product."



Send for Bulletin 0504

DE LAVAL *Pumps and Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL 197

mechanical collectors, and acquisition of the bag-type filter operations of Turner & Haws will enable Koppers to offer industry all three major types of industrial dust collectors, or combinations of them.

A. G. McKEE SCHEDULES EXPANSION PROGRAM

▲ Expansion plans for the home office and engineering facilities of Arthur G. McKee & Co. were announced by H. E. Widdell, president.

First step in this program was the purchase of about 74,000 sq ft of land in the rear of the present headquarters building in Cleveland, Ohio.

A modern two-story building with about 30,000 sq ft of floor space initially will be constructed immediately on the new site.

Instead of enlarging the present building, it was decided to construct a separate building which permits the latest design in office and engineering facilities and enables the company to more readily expand in the future.

NATIONAL TUBE SETS MONTHLY INGOT RECORD

▲ An all-time monthly steel ingot production record of 330,015 tons was established during October by National Tube Division of U. S. Steel Corp. The previous record, which was established in October, 1952, was exceeded by 8200 tons.

Both National Works, McKeesport, Pa., and Lorain Works, Lorain, Ohio, contributed to the new all-time high by achieving new plant steel ingot records. At the same time, new all-time iron production records were recorded in the blast furnace departments at both plants.

APPROPRIATIONS FOR 1956 EXPANSION ANNOUNCED

▲ A $7,000,000 expansion and modernization budget for 1956 was announced by the Timken Roller Bearing Co. for the purpose of purchasing new equipment, and increasing the capacities of the Steel and Tube, Rock Bit and Bearing Divisions.

Included in the $7,000,000 appropriation is the enlargement and modernization of the company's Gambrinus tube mill, installation of two annealing furnaces, construction of

(*Please turn to page 206*)

TAYLOR MADE *Alloy Steel* CHAIN!

assures a greater safety factor!

A certificate of test is issued with every Taylor Made Alloy Steel Chain to prove that it has been tested to twice its working load limit. This represents a safety factor twice that of wrought iron chain.

stays on the job longer!

Taylor Made Alloy Steel construction and controlled heat-treatment increases the life of the chain—makes it tougher, harder and more resistant to shock, grain-growth and work-hardness than wrought iron types.

costs less than wrought iron types!

Actual operating experience in scores of plants has proved that Taylor Made Alloy Steel Chain's greater safety, superior strength and longer life assures far lower chain costs in the long run.

See your DISTRIBUTOR or send coupon!

S. G. TAYLOR CHAIN CO. — Hammond, Ind. Pittsburgh, Pa.

S. G. Taylor Chain Co.
Dept. H
Hammond, Indiana

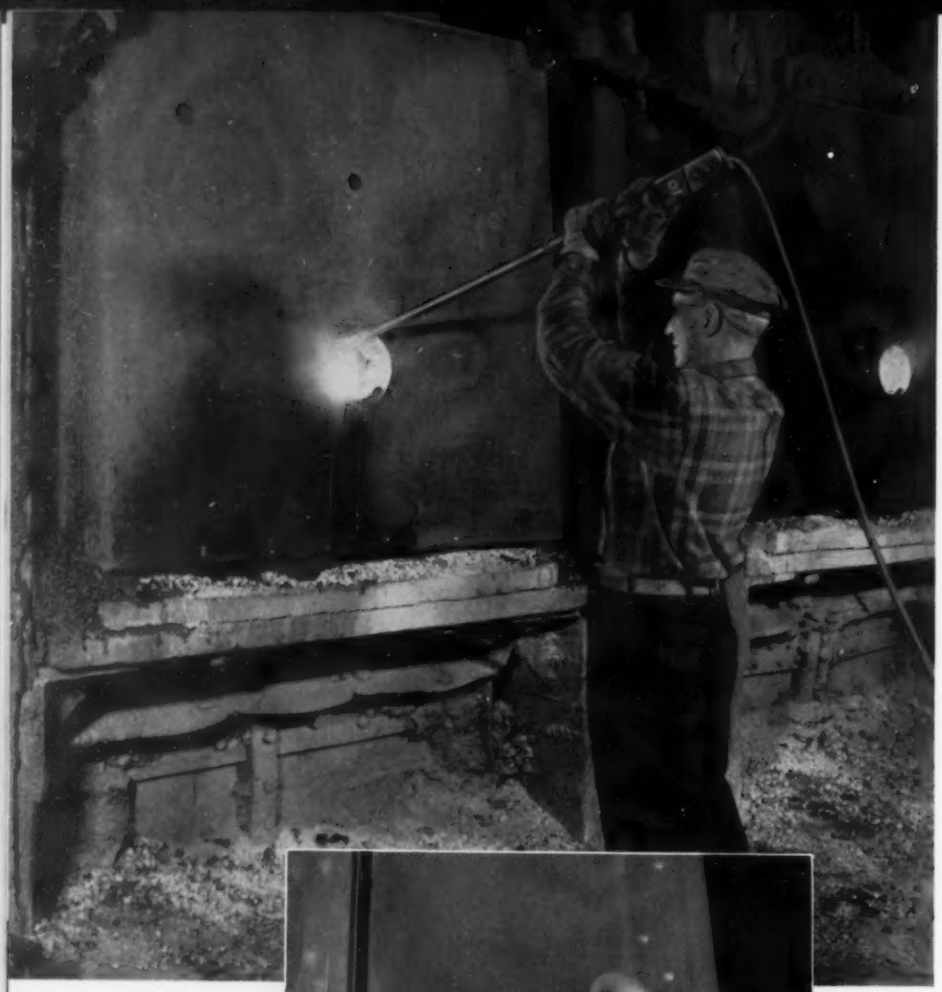
Please send Bulletin 13 giving all the facts and specifications on Taylor Made Alloy Steel Chain.

Name_____

Address_____

City_____ State_____

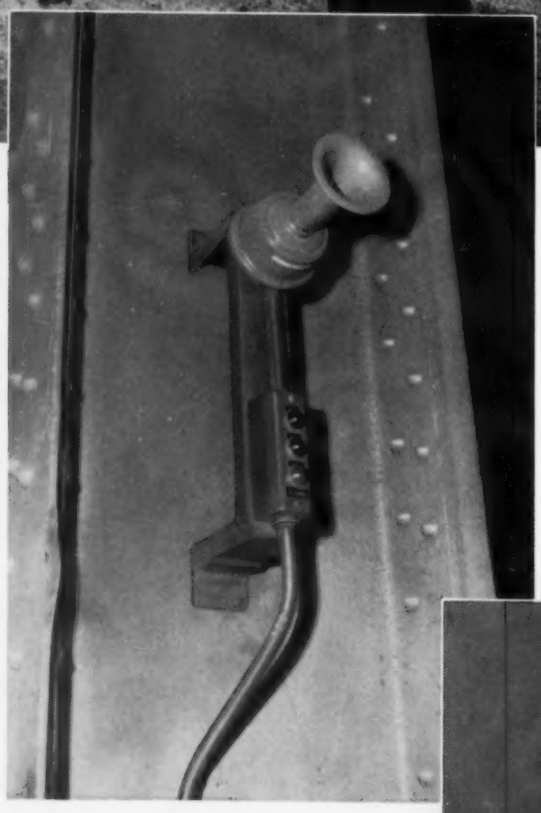
TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873



The

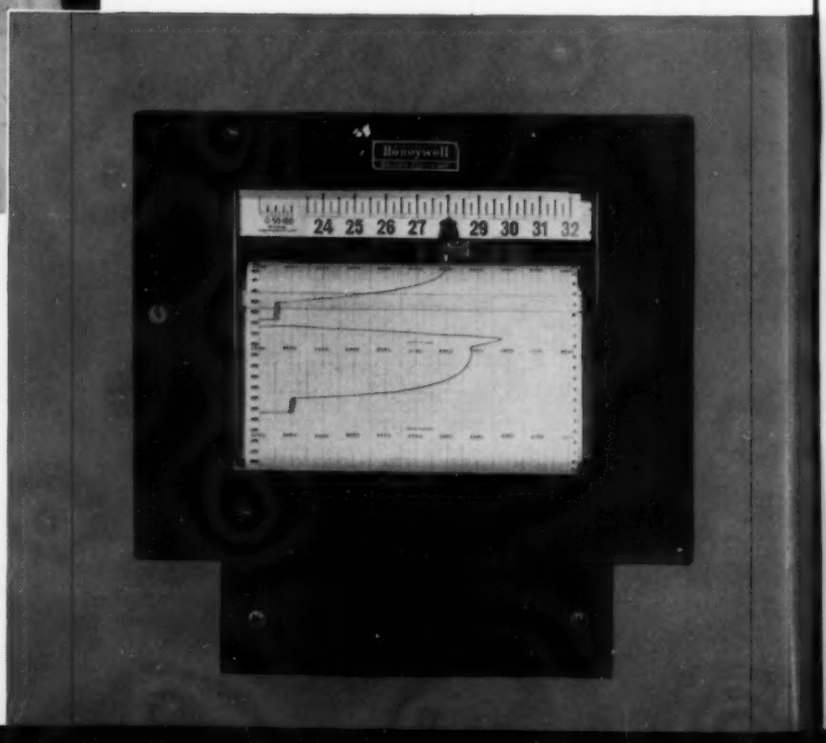
1

Insert the Brown thermocouple *through the wicket hole and into the bath. The assembly weighs less than 40 pounds . . . is easily handled by one man.*



2

Watch the signal lights. *Mounted near the furnaces, they tell the operator when the couple is correctly connected, instrument is standardized, couple is preheated, and measurement is completed. There's no need to have a second man stationed at the instrument.*



3

A complete, accurate record *of the measurement is drawn on the* ***ElectroniK*** *instrument, which can be located hundreds of feet from the furnace. The recorder standardizes itself the instant a thermocouple is connected . . . stays always ready to deliver top accuracy.*

accurate, simple economical way to measure molten steel bath temperature

MEASUREMENTS of molten steel bath temperatures in open hearth and electric furnaces reach a new high in simplicity and precision . . . and a new low in cost . . . with *ElectroniK* instrumentation. The automatic signalling system eliminates the guesswork of arbitrarily set immersion time. It tells the operator the instant that the measurement is completed . . . enables him to withdraw the couple immediately and thus prolong its useful life, without detracting from accuracy of measurement.

The system ends all doubt about thermocouple condition. If the first signal—a green light—fails to light, the operator knows that the thermocouple is open. One company estimates that the system has paid for itself by preventing the expense of contaminated couples.

One man can perform the entire measurement. He doesn't need to consult the recorder, which can be mounted at any desired distance from the furnace. You save on thermocouples, on production . . . even on chart paper, for the chart moves only when a measurement is being made. And you get the high order of precision in bath temperature readings that enables you to eliminate hot or cold heats, to reduce skulls and stool stickers, and improve ladle and mold life.

Your local Honeywell sales engineer will be glad to discuss how you can profitably utilize the *ElectroniK* system in your own shop. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Data Sheet No. 6.4-8b, "Molten Steel Temperature Measurements."**

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

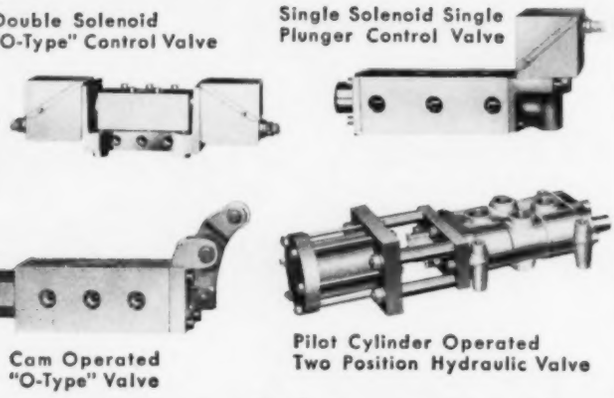
SELECT

Quick-As-Wink®

AIR AND HYDRAULIC

CONTROL VALVES

DESIGNED AND BUILT TO ASSURE



Double Solenoid "O-Type" Control Valve

Single Solenoid Single Plunger Control Valve

Cam Operated "O-Type" Valve

Pilot Cylinder Operated Two Position Hydraulic Valve

efficient and dependable operation

of your machines and machinery

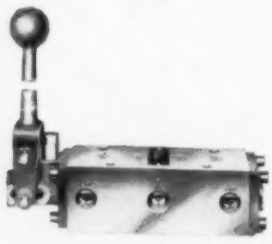
Can you afford to gamble with less?

• Why build — or buy — expensive machines and then restrict their output and risk breakdowns and production tie-ups because of inferior control valves?

Positive and fast acting Quick-As-Wink valves meet the most exacting requirements. They deliver dependable precision performance month after month and year after year. Machine operators, foremen, superintendents *and machine builder trouble shooters* will tell you that there is nothing better than a Quick-As-Wink valve. REMEMBER,— your efforts to increase production and cut costs can only be as successful as the air and hydraulic valves that control the operations. Don't gamble. Play safe. Specify Quick-As-Wink valves. Get full details. Write for Bulletin No. 531, *Today!*

Ask us also about . . .

FOOT OPERATED SLIDING SLEEVE VALVE ⅜" to 1" sizes. Single pedal spring return and two pedal designs. Operator has both hands free to handle the work.

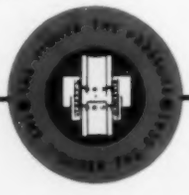


LEVER OPERATED SINGLE PLUNGER VALVE ⅜" to 1½" sizes. Widely used for controlling single and double acting cylinders and as pilots for other valves.

Quick-As-Wink®

AIR AND HYDRAULIC

Control Valves



Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1929 East Pershing St., Salem, Ohio

(Continued from page 203)

an oxygen plant, the construction of a central warehouse at the company's Bucyrus plant, and the purchase of automatic screw machines and grinding equipment for all plants of the company.

EXPANDS PHILADELPHIA LABORATORY FACILITIES

▲ General Electric Co.'s Switchgear and Control Division has just completed a $500,000 expansion of testing facilities at its Philadelphia laboratories.

The new testing facilities will be capable of producing short-circuit currents as high as 100,000 amperes at 700 volts and 40,000 amperes at 1400 volts. Two motor-generator sets with associated control equipment are being installed in the existing test building.

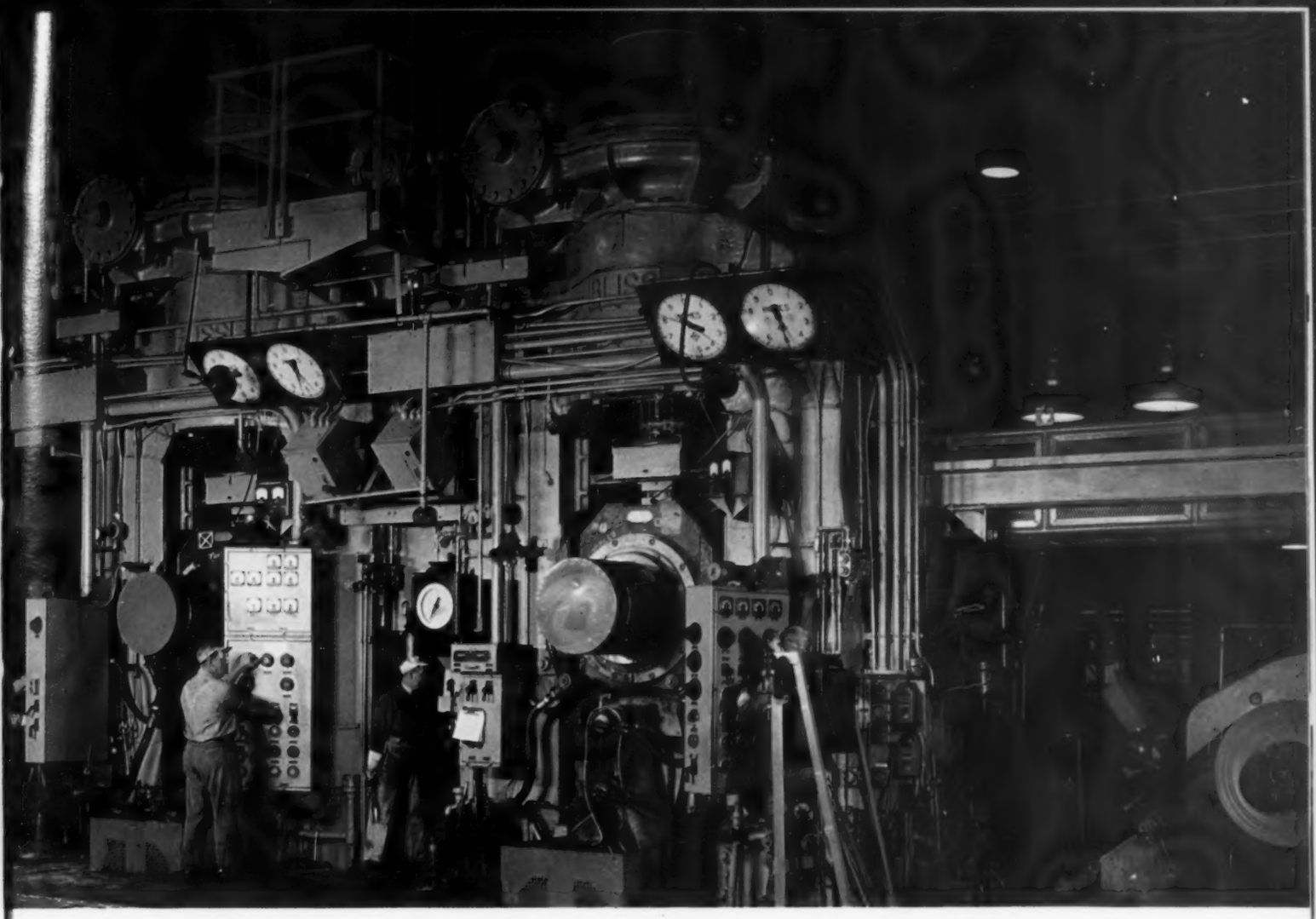
In addition, the d-c facility is equipped with complete instrumentation for observing high speed performance characteristics.

APPROVE CONTINENTAL SALE TO BLAW-KNOX

▲ Stockholders of Continental Foundry and Machine Co. at a special meeting on October 31, approved the sale for cash of its physical assets, inventories and business of the company to Blaw-Knox Co., and also approved management's proposal for complete liquidation of Continental Foundry & Machine Co. A total of 395,612 shares, representing approximately 79 per cent of the outstanding shares voted approval and only about 5 per cent opposed.

Continental will receive from the sale to Blaw-Knox approximately $19,700,000, the exact figure being subject to final adjustments on date of closing. Payment to Continental stockholders upon complete liquidation of all assets is expected to approximate $52 per share, of which approximately $40 will be distributed in December, 1955, a second distribution of about $5 per share to be made within 60 days thereafter, with the remainder to be paid as quickly as final liquidation can be effected.

SOMETHING TO SELL?
USE THE ENGINEERING MART



At Jones and Laughlin Steel Corporation...

High Speed Tin Temper Mill has **RUGGEDNESS** and **POWER** to match

Speed, ruggedness, power and the latest coil-handling equipment . . . characterize this tandem mill at J & L. These features, combined with modern electrical control systems, make this one of the most advanced mills in use today.

Its top-rated speed of more than 6000 fpm furthers the trend to faster, more reliable mills . . . capable of better quality at higher speeds . . . with easier control.

Speed, power and rapid acceleration and deceleration features . . . all these pay off in terms of greater tonnage. In addition, mechanical and semi-automatic coil handling equipment—designed for extra large coils—at entry and delivery ends add to personnel safety and increase the productivity of this mill.

This J & L installation is one of many startling developments in modern mills engineered by Bliss for leaders in the steel and non-ferrous plants both here and abroad. For more information about Bliss rolling mills, write today for Catalog 40-A . . . Bliss' 60-page rolling mill brochure.

Remember: **BLISS** SINCE 1857 **for Presses, ROLLING MILLS, Special Machinery**

E. W. Bliss Company • General Office: Canton, Ohio

ROLLING MILL DIVISION: SALEM, OHIO

Subsidiary: The Die Supply Company, Cleveland, O. • E. W. Bliss (England) Ltd. • E. W. Bliss Company (Paris) France

U. S. Plants in Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; San Jose, California; Pittsburgh and Midland, Penna. *Branch Offices in* Burbank, Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Pittsburgh, Rochester, Salem, San Jose, Toledo, Washington, D. C.; and Toronto, Canada. *Other representatives throughout the world*

CAR BY POLLOCK

Announcing...the Johnston Corrugated Cinder Pot

with NEW SHORT SUPPORTS

A new design development now makes the famous Johnston Corrugated Cinder Pot even longer-lasting than before. It is the brand new short support, already in use on Johnston pots in the plants of two leading steel producers.

The short supports are coupled to the pot at the same advantageous area as before: near the bottom, where the walls are coolest and strongest. However, instead of hooking over the top rim of the bail ring, the supports bolt into a set of lugs on its bottom surface (see photo). Thus, the pot walls have no opportunity to scrape or bang against the backs of the supports.

The Johnston pots with the new supports have all the other advantages that have led the steel industry to place more than 2000 of them in service. Advantages like curved sidewalls that resist cracking and inward creep...expansible saw-cut rims that strengthen the pot top...corrugations that expand and contract freely and dissipate heat faster...optional copper bottom-coats that prevent "stickers".

Why not learn more about the reasons behind the strong trend to Johnston Cinder Pots? We will be glad to explain our policy of engineered slag-handling equipment and how it can be applied to your own slag disposal problem. Simply write to...

MACKINTOSH-HEMPHILL
DIVISION OF
E. W. BLISS COMPANY

MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH · U.S.A. · M H

Makers of the rolls with the Striped Red Wabblers

BLISS

Pittsburgh and Midland, Pa.

cast mill rolls • Johnston cinder pots • rotary tube straighteners • Y-type cold mills
heavy-duty lathes • steel and special alloy castings • end-thrust bearings

TO GET MORE SIZES OUT OF A WAREHOUSE THAN YOU PUT IN...

Use These Waterbury Farrel "Experts"

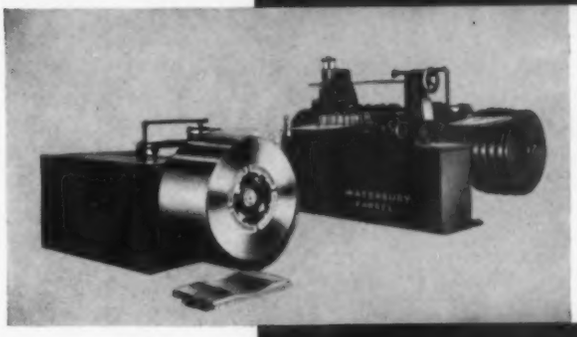
- **Available In Sizes To Fit Your Requirements**
- **Engineered For Efficient Low Maintenance Operation**

These WF units make your strip metal warehouse a streamlined production unit . . . able to produce specified sizes on the spot, from mill coils. You minimize storage space and inventory . . . step up deliveries . . . cut initial costs on shipping and packing . . . meet and beat competition.

Embodied in each piece of WF warehouse equipment is the up-to-date design and sound engineering which have built Waterbury Farrel's reputation in metal-working machinery since 1851.

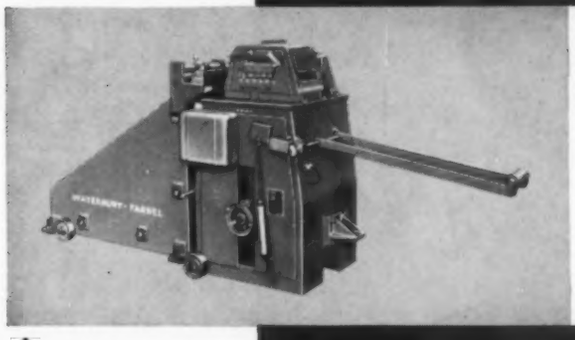
Write for further details on any of the units shown or mentioned here.

Eleven Roll Straightener. 1⅞" diameter x 14" face rolls. Upper rolls individually adjustable. Straighteners are available in a range of sizes with roll diameters and widths to meet varying requirements.



Gang slitting line consisting of payoff stand, coil lift, slitter and winder—built in various sizes to handle a wide range of gauges and widths.

Gang slitting machine arranged for slitting sheet stock—also available in several sizes.



Portable Roll Feed Straightener With Detachable Coil Box. Has variable speed drive and feed rolls on the front side. Nine 1¼"x 7" rolls. Other sizes available.

18" Motor-driven Cut off Saw for rods and tubes. Fully enclosed, including hinged saw guard.

WF-16

WATERBURY FARREL FOUNDRY & MACHINE CO. • WATERBURY, CONN.

Offices: Chicago, Cleveland and Millburn, N. J.

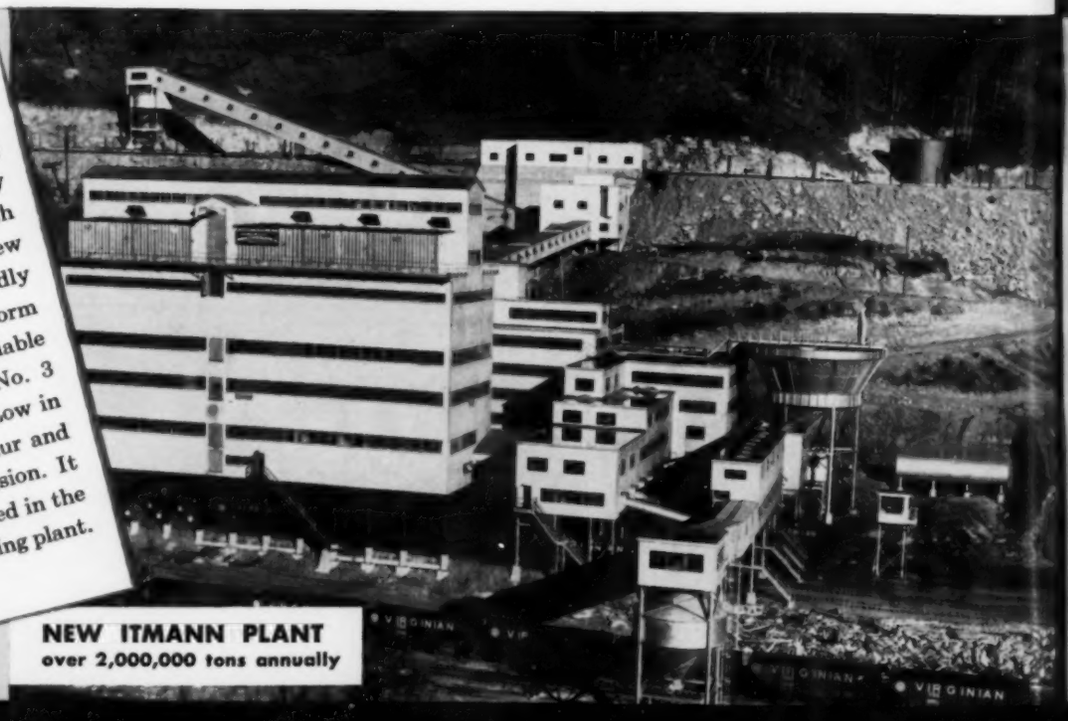
POWER PRESSES — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc. MILL MACHINERY — Rolling Mills: Strip, Rod, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc. WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc. COLD PROCESS BOLT & NUT MACHINERY — Headers (all types) • Rivet Machinery • Trimmers • Thread Rolling Machines • Slotters • Nut Formers and Tappers, etc.

are you satisfied with your COKE and FURNACE OPERATIONS?

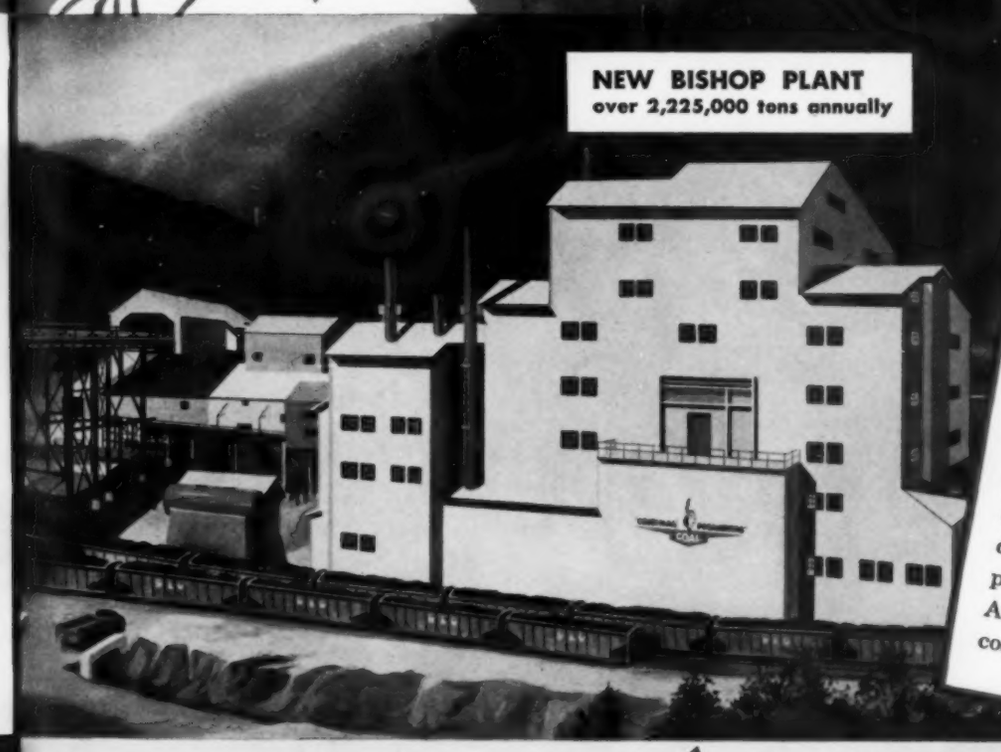
USE "ORIGINAL POCAHONTAS" COAL

ITMANN MINE

produces low volatile Pocahontas Coal that is perfect for making coke for furnace and foundry use. Over 2,000,000 tons each year are refined in this new plant where quality is rigidly controlled, shipping a uniform product. Itmann is a reliable and uniform Pocahontas No. 3 seam metallurgical coal. Low in ash, moisture and sulphur and with the correct expansion. It is dried and cleaned in the world's largest air cleaning plant.



NEW ITMANN PLANT
over 2,000,000 tons annually



AMONATE AND BISHOP MINES

are medium volatile Pocahontas coals, approximately 21% to 23% volatile. They make a splendid coke and will replace both low and medium volatile coals or all low and part of high volatile, requiring only a mixture of 2 coals.

VERY LOW IN ASH — .55 sulphur — unusually low expansion.

These new multi-million dollar preparation plants have just been completed. Here, coal is washed, dried, and uniformly sized. Annual production of 5,000,000 tons of Amonate and Bishop metallurgical coals.

"ORIGINAL POCAHONTAS" COAL

May we furnish You additional information?

POCAHONTAS FUEL COMPANY

TERMINAL TOWER • CLEVELAND

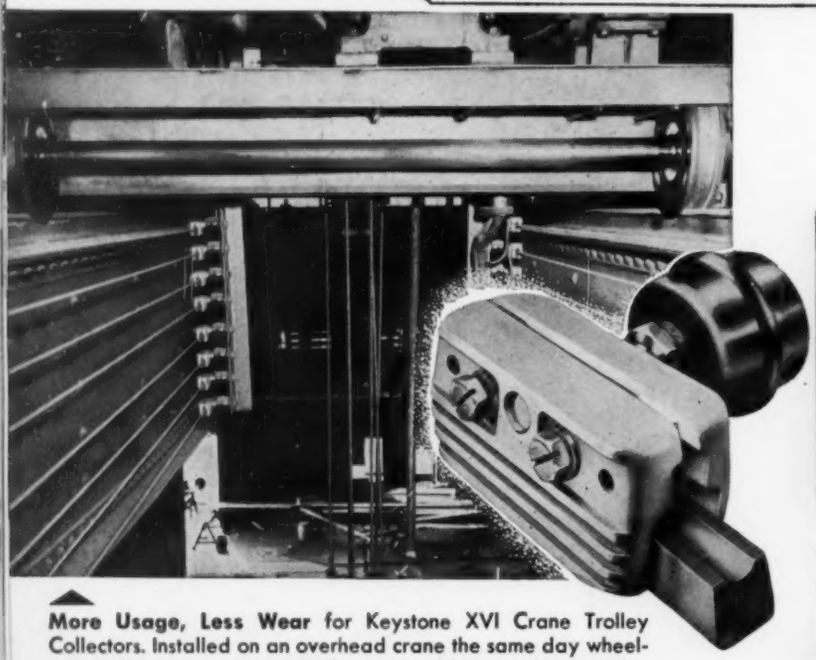
CHICAGO CINCINNATI DETROIT NEW YORK RICHMOND POCAHONTAS, VA.

SALEM, MASS. PORTLAND, ME. and other leading cities

Drop all your

The ELECTRIC SERVICE

1. Design New
2. Modernize
3. Recommend



More Usage, Less Wear for Keystone XVI Crane Trolley Collectors. Installed on an overhead crane the same day wheel-type collectors went on a similar crane, they were in operation 50% longer each day. When wheels were removed due to failure, the XVI renewable carbon shoe contact inserts still had many months of life ahead.

Long, Hard, Hot Service at Birdsboro Steel Foundry & Machine Co. Loaded furnace cars move in and out of heat treating furnaces safely and without a hitch. Rails on each furnace car contact stationary columns equipped with Keystone LMI Pony-size Contact Rail Collectors. These reversible collectors offer 30% greater contact travel, efficient current transfer.

Rugged Reliability in the face of dirt, rainy and icy conditions, and severe misalignment. These Keystone Inverted-V Universal Collectors have operated for more than seven years at the Alan Wood Steel plant. They give positive contact wherever the going is rough, tough, and dirty—in open hearth, coke plant, blast furnace.

ELECTRIC SERVICE MANUFACTURING CO.

third-rail problems on his desk!

Engineer will collaborate and . . .

Keystone Conductor System (Steel, Aluminum or Copper)

your Present System for Greater Efficiency and Economy

Suitable ESM Equipment for the Job

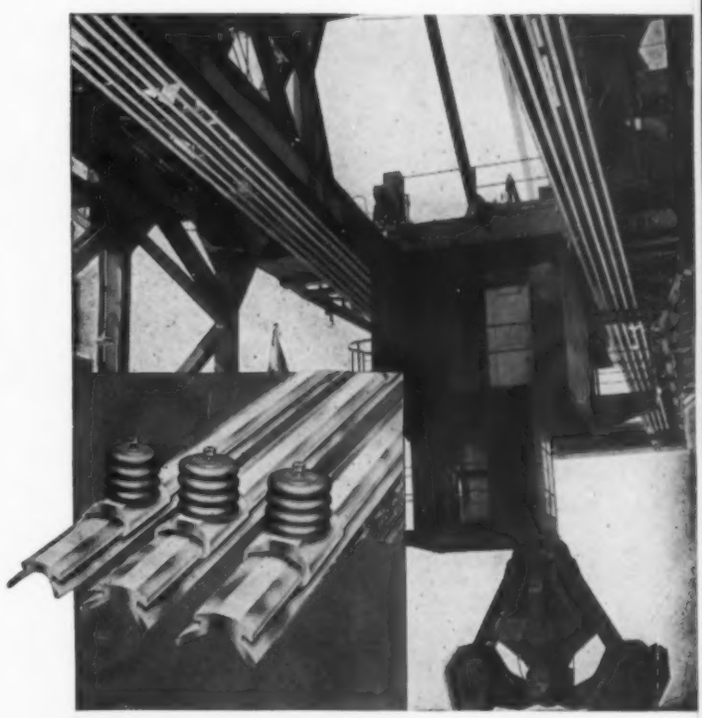
INDUSTRIES rely heavily on the Electric Service engineer for designing or converting power Conductor Systems. There are three main reasons:

ESM ALUMINUM, STEEL, COPPER SYSTEMS—All three are designed and built by Electric Service. Each has its proper applications, resultant economies. The system specific to *your* needs is recommended without bias.

ESM SERVICE IS COMPLETE—Engineering counsel is backed up by the complete line of Keystone Equipment and by ESM installation specialists. Electric Service engineers new systems, modernizes inadequate systems, repairs existing systems.

ESM PRODUCTS ARE JOB-PROVED—They're at work on all types of materials handling equipment in every industry—steel mills, power plants, docks, rail yards, processing plants. Typical installations shown here illustrate the scope and reputation of Electric Service in this electrical power-transmission field.

What's your problem?—insufficient power? . . . severe weather or corrosion conditions? . . . production-sapping shutdowns? . . . excessive maintenance? Write today for assistance.



Aluminum Reduces Corrosion, cuts deadweight for Canton Co. Baltimore Harbor's salty dampness doesn't faze Keystone Integrated Aluminum Conductor System. High-speed ore unloader utilizes aluminum on trolley conductors and on 1200-ft., 2300-volt main runway. Aluminum Under-running System has high current capacity, low voltage drop, sensitive control.

Unhurt by Volts, Jolts are the Keystone Insulators on Fairless Works coke oven rails. Petticoat-type Porcelain Insulators resist contamination by dirt, moisture. Shock-proof, non-absorbent moulded type Insulators team up to protect over-running contact rails under severe conditions.

KEYSTONE
INDUSTRIAL
POWER
PRODUCTS

Philadelphia 32, Pa.

Represented in Canada by Lyman Tube and Bearings, Ltd., Montreal and Toronto

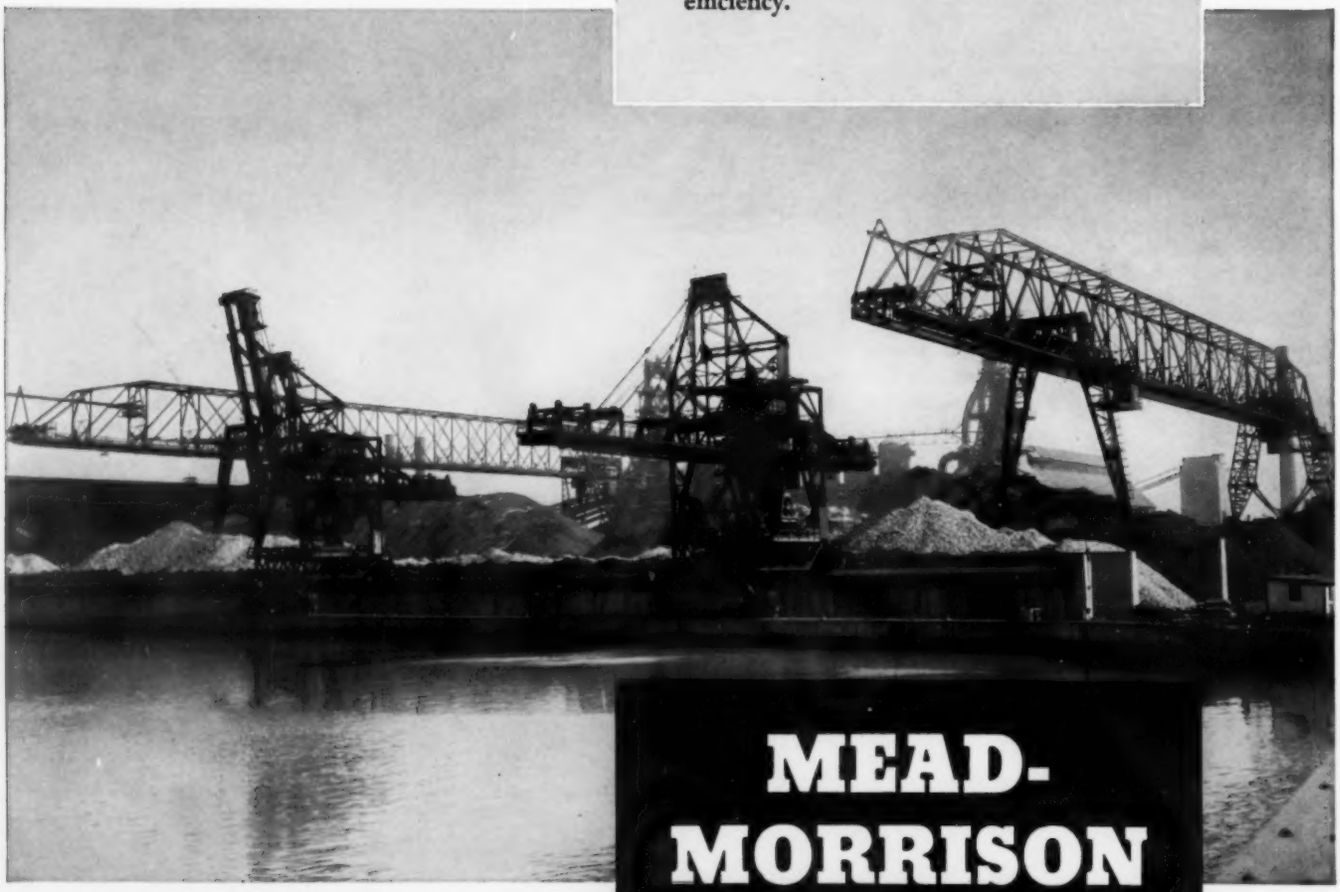
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at a large midwestern steel mill.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

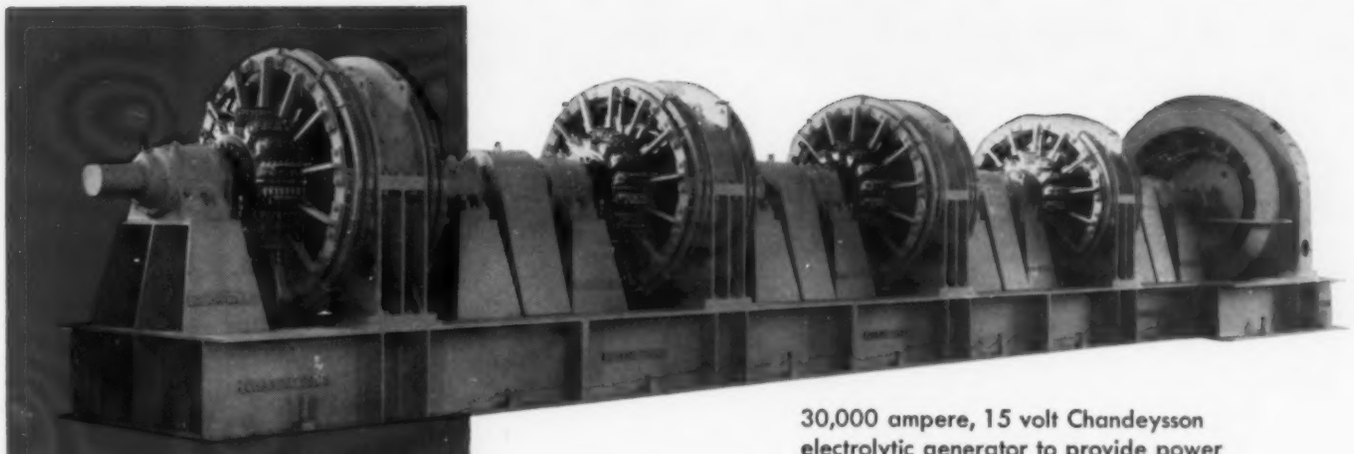
If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

MK8OS



30,000 ampere, 15 volt Chandeysson electrolytic generator to provide power for tin plating at United States Steel's Gary Sheet and Tin Mill.

U S STEEL installs this BIG, NEW Chandeysson ELECTROLYTIC GENERATOR

for a Lifetime of Low-Cost Power Conversion!

How long will this giant motor generator serve dependably, without loss of efficiency? Some Chandeysson units built as long as half a century ago are still in service . . . and this modern Chandeysson is even more efficient and durable than its predecessors.

There's no secret to the amazingly long service life of Chandeysson electrolytic generators. It's simply a combination of the finest, most durable materials; painstaking design for maximum efficiency with a minimum of wear; conservative engineering with ample overload capacity; and craftsmanship by electrolytic generator specialists. To obtain this perfection, all parts of Chandeysson generators except brushes are built in our plant. You can depend on delivery, installation, performance and service.

Whatever your power conversion requirements, you'll save money four ways with a Chandeysson:

1. Use less power
2. Get more out of the power you pay for
3. Be sure of power when you need it most
4. Enjoy lifetime power dividends

FOR FULL INFORMATION mail this coupon . . . or write:

CHANDEYSSON ELECTRIC COMPANY
4076 Bingham Avenue, St. Louis 16, Mo.

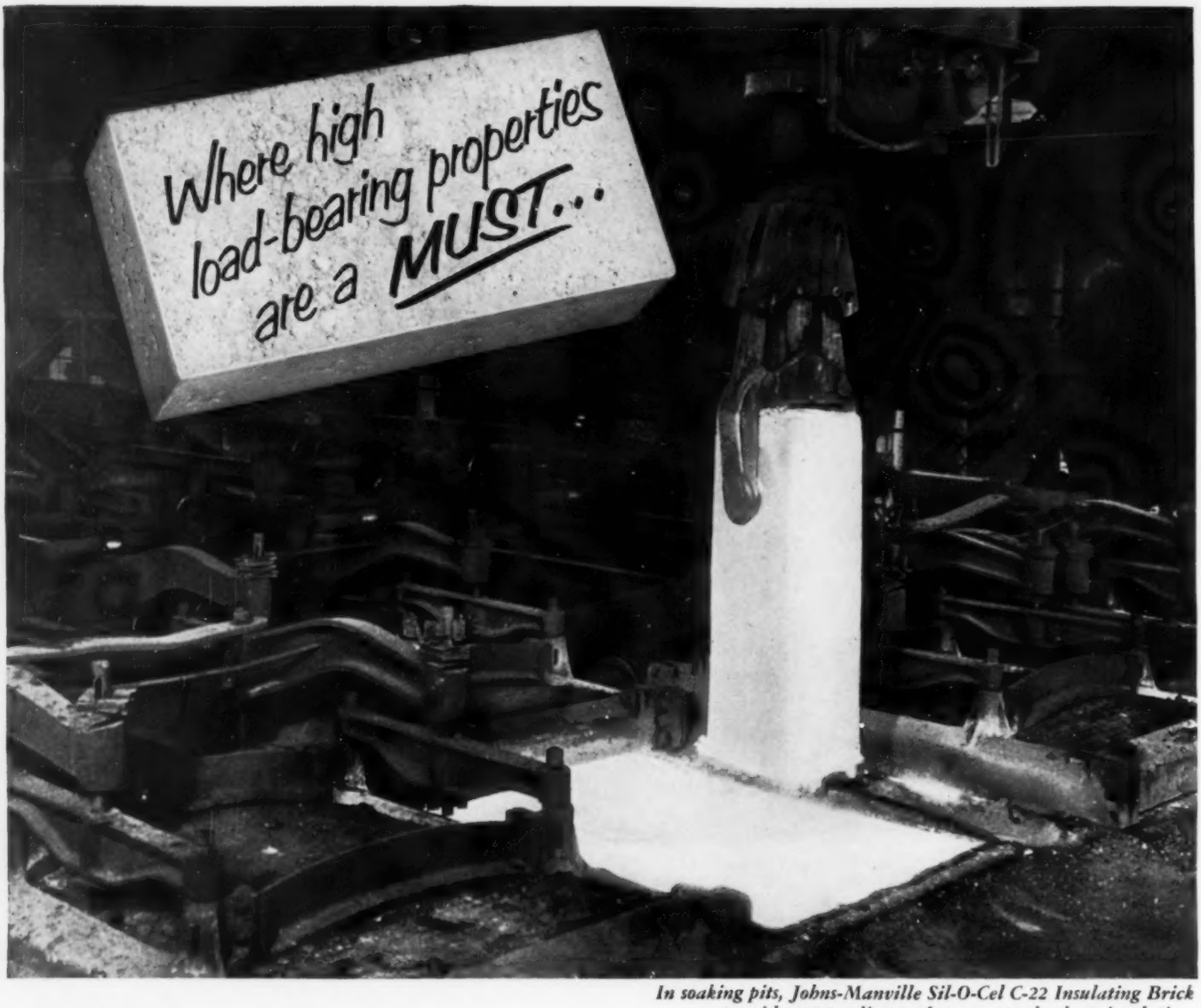
CHANDEYSSON ELECTRIC COMPANY
4076 Bingham Avenue, St. Louis 16, Mo.

Name.....

Company.....

Address.....

City.....Zone.....State.....



In soaking pits, Johns-Manville Sil-O-Cel C-22 Insulating Brick provide outstanding performance as back-up insulation.

Specify

Johns-Manville SIL-O-CEL C-22 Insulating Brick

the diatomaceous silica brick that retains its high cold crushing strength of 700 psi throughout normal service range

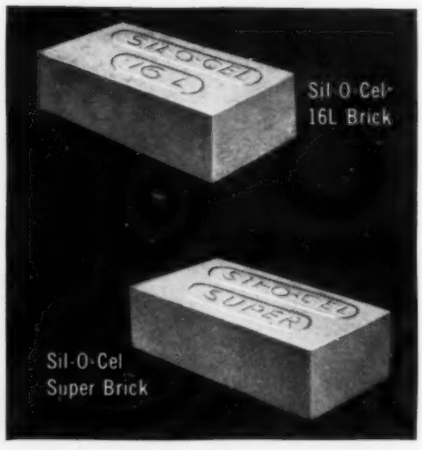
Because of its exceptional strength Sil-O-Cel C-22 Insulating Brick has gained wide acceptance as an all-purpose insulating brick. It is especially recommended for soaking pits, open hearth bottoms, slab heating furnaces, hot blast stoves, coke ovens and other high temperature equipment.

Millions of microscopic cells provide Sil-O-Cel C-22 brick with excellent heat resistance up to 2000F. It has a thermal conductivity of only 1.88 Btu in/sq ft/F/hr at 1000F mean temperature. In addition, with a density of 38 lb/cu ft, it is light and easy to handle.

For direct exposure or back-up to 1600F, use Sil-O-Cel 16L Insulating Brick. This newest member of the J-M diatomaceous silica insulating brick family has *less than 0.1% reversible thermal expansion at 1600F.* Conductivity is 1.07 Btu in/sq ft/F/hr at 1000F mean temperature with a density of 33-35 lb/cu ft. Cold crushing strength is 350 psi. Sil-O-Cel 16L serves equally well as back-up insulation or exposed refractory lining.

For back-up at higher temperatures, specify Sil-O-Cel® Super Insulating Brick with an unusually high temperature limit of 2500F.

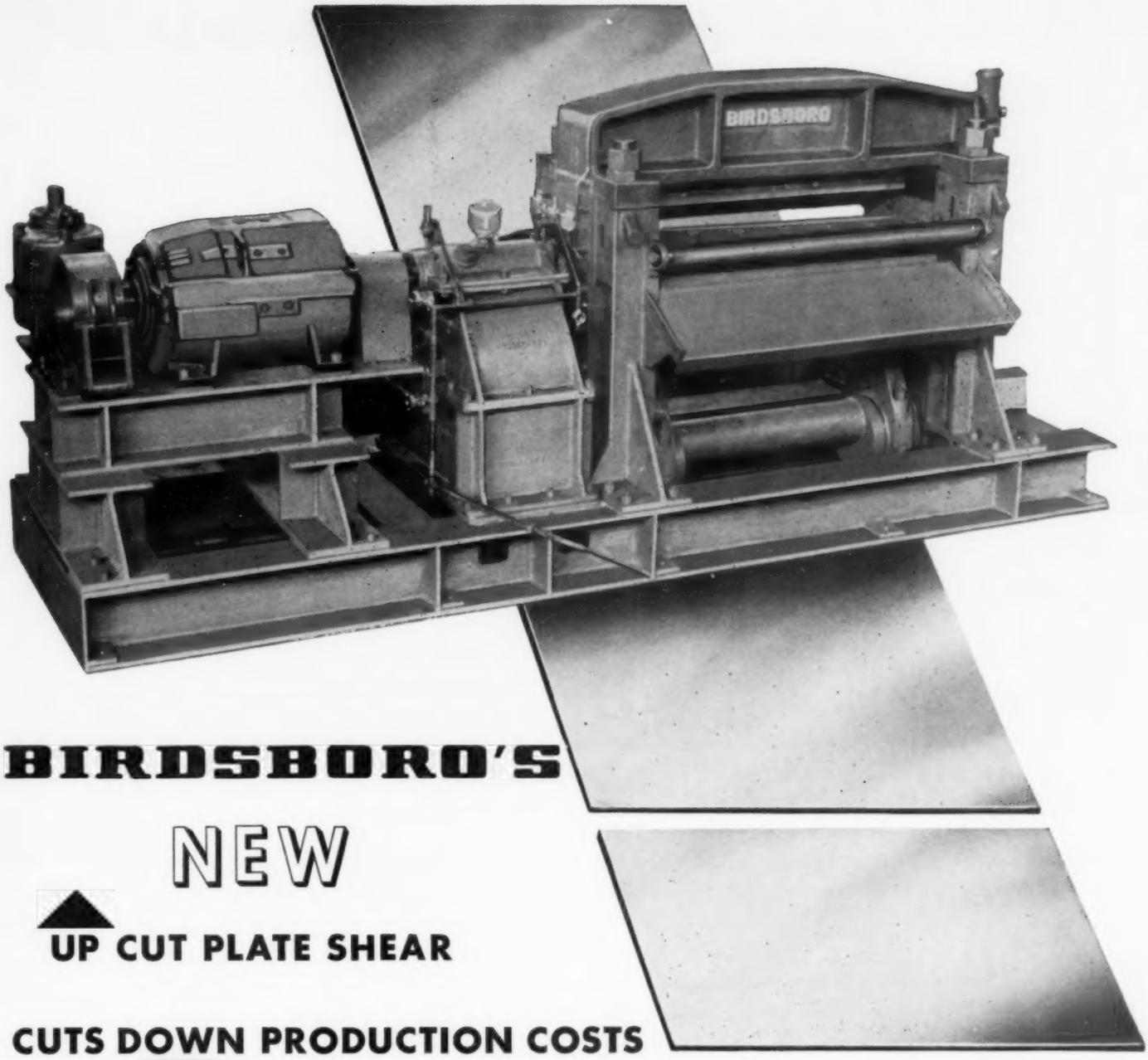
Write today for further information on Sil-O-Cel Insulating Brick and Insulating Fire Brick. Ask for Brochure IN-115A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 565 Lakeshore Road East, Port Credit, Ontario.



JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first in* INSULATION

MATERIALS · ENGINEERING · APPLICATION



BIRDSBORO'S NEW

▲ UP CUT PLATE SHEAR

CUTS DOWN PRODUCTION COSTS ▼

Designers and Builders of:

STEEL MILL MACHINERY
HYDRAULIC PRESSES
CRUSHING MACHINERY
SPECIAL MACHINERY
STEEL CASTINGS
Weldments "CAST-WELD" Design
ROLLS: Steel, Alloy Iron, Alloy Steel

• Talk about a *tough* cutting job! 175,000 lbs. shearing strength is required to bite through ⅜" thick stainless steel plate up to 62" wide. BIRDSBORO helped supply the answer . . . with a new start-stop type of Up-Cut Plate Shear. Special provisions protect the lower knife slide from scale contamination. Producing new type shears is an old story for BIRDSBORO. For over a half-century, BIRDSBORO service has been handled by a series of design, engineering and production experts who can produce machinery to fit any of your requirements.

MM-45-55

BIRDSBORO

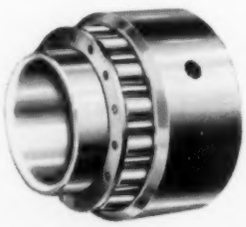
BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. Offices in Birdsboro, Pa. and Pittsburgh, Pa.

HYATTS HELPED THIS MILL ROLL UP A WORLD'S RECORD

522 ingots in one 8-hour turn at J & L's Aliquippa Works!

The main table, approach table, runout table and lineshafting on this record-breaking 46″ Blooming Mill are equipped with HYATT Roller Bearings. Why? Because Jones & Laughlin, like so many leading steel producers, has found that the name HYATT is the hallmark of highest quality in roller bearings. It means expert engineering, fine fabrication and above all, *outstanding performance*—the ability to keep on absorbing punishment long after ordinary bearings have hit the scrap-heap!

No wonder HYATTS rate so well with J&L! If *you* want the same kind of record-breaking service from roller bearings, the man to see is as near as your telephone—your HYATT Sales Engineer. Give him a ring right now and let him give your production a lift! Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT

ROLLER BEARINGS

STRAIGHT ▯ BARREL ▯ TAPER ▯

Personnel News...

J. W. Kinnear, Jr., formerly assistant vice president —engineering at U. S. Steel Corp., has been named vice president—operations of Tennessee Coal & Iron Division. He succeeds **J. M. Spearman,** who becomes assistant to the president of T. C. & I. **E. L. Tindall** succeeds Mr. Kinnear as assistant vice president—engineering. At the same time, **P. E. Thomas** was named to succeed Mr. Tindall as chief engineer—steel. Mr. Kinnear joined U. S. Steel in 1923 as a laborer at Homestead Works. He became assistant manager of operations—Pittsburgh district in 1940, serving in that capacity until 1947 when he left the corporation to become president of Firth-Sterling Steel and Carbide Co. He returned in 1951 as assistant to vice president—manufacturing, and served from September 1, 1951 until March 1 of this year as general superintendent of Edgar Thomson Works. Mr. Tindall joined U. S. Steel as a combustion engineer at the company's South Works in Chicago in 1935. He was superintendent of the fuel and combustion department at South Works prior to being transferred to the company's engineering division in Pittsburgh as a power, fuel and steam engineer in 1940. He was made chief engineer of the company's Edgar Thomson Works in 1947, and in 1948 was named Pittsburgh District engineer of Carnegie-Illinois with headquarters in this city. On January 1, 1953, he was appointed chief engineer—steel, the post he held at the time of his new appointment. Mr. Thomas joined U. S. Steel in 1924 at the Gary, Ind., plant where he served as a wireman until 1929. He left the employment of U. S. Steel from 1929 to 1936, rejoining the corporation as a test engineer at Gary. He advanced through various positions in the engineering department until 1947 when in successive steps he was made assistant division superintendent of maintenance, chief engineer and assistant general superintendent. He was appointed assistant chief engineer—steel with headquarters in Pittsburgh in 1954, the capacity in which he served prior to his new appointment.

Frank A. Rowe has succeeded **E. C. McDonald** as superintendent of the combustion engineering department at Republic Steel's Cleveland, Ohio, steel plant. Mr. Rowe had been assistant superintendent of the department since 1935.

Alvin J. Scheel has been appointed assistant general superintendent, Fairless Works, National Tube Division, U. S. Steel Corp. Mr. Scheel joined U. S. Steel in 1933 at Lorain Works, Lorain, Ohio. In 1937 he was promoted to foreman in the rolling mills, with subsequent promotion to general foreman of the conditioning, finishing and shipping departments at Lorain Works. On August 16, 1947, he was transferred to National Works, McKeesport, Pa., as assistant superintendent, rolling mills and was advanced to superintendent of this department on March 1, 1950. On January 16, 1954, Mr. Scheel was appointed superintendent, Open Hearth and Bessemer department, where he served until his present promotion.

Roy E. Carter has been promoted to superintendent of maintenance at Green River Steel Corp. He was formerly master mechanic. **Fred E. Lewis, Sr.** succeeds Mr. Carter as master mechanic. He was formerly with Crucible Steel Co. and Brazilian National Steel.

A. L. Billeter, formerly general superintendent of U. S. Steel's Irvin Works, was appointed assistant to vice president, operations—steel. In his new position Mr. Billeter will assist the vice president in matters pertaining to flat rolled product operations of the company. At the same time, it was announced that **T. W. Hunter,** assistant general superintendent of Irvin Works, will succeed Mr. Billeter as general superintendent, and that **A. T. Duff** will succeed Mr. Hunter as assistant general superintendent of the plant. Mr. Billeter began his career with U. S. Steel in 1919 as a foreman in the annealing department of the Gary Sheet and Tin Mill, Gary, Ind., and was transferred to Irvin Works as superintendent of the cold reduction department in 1937. Appointed superintendent of U. S. Steel's plant at Vandergrift, Pa., in 1944, he returned to Irvin Works in 1947 as assistant general superintendent. On February 17, 1950, he was named general superintendent of Irvin Works. Mr. Hunter joined U. S. Steel in 1936 as assistant to the tin house superintendent of Shenango Works. In 1937, he transferred to Irvin Works as assistant to the superintendent of the tin finishing department and after several promotions was made superintendent of flat products at the plant in 1941.

J. W. KINNEAR, JR.

E. L. TINDALL

P. E. THOMAS

FRANK A. ROWE

A. L. BILLETER

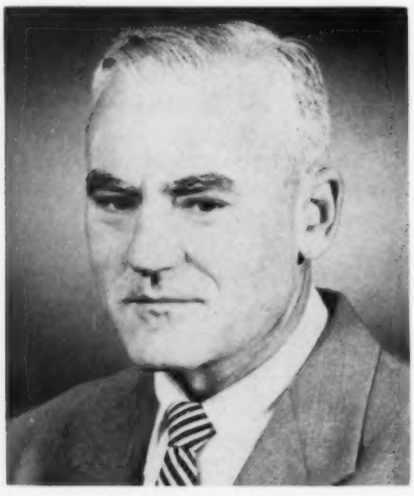
T. W. HUNTER

A. T. DUFF

R. CONRAD COOPER

He was transferred to Gary Sheet and Tin Mill in 1944 and was tin mill division superintendent at the time of his return to Irvin Works as assistant general superintendent on October 1950. Mr. Duff began his U. S. Steel career as a weigher in the cold reduction department of Irvin Works in 1938 at the time Irvin was first placed in operation. He served successively as foreman and assistant superintendent of the 80-in. hot strip mill, general foreman of the tin finishing department, assistant superintendent of cold reduction and superintendent of Irvin's galvanizing department. In 1950, he became superintendent of the 80-in. hot strip mill and two years later was transferred to Fairless Works as superintendent of tin finishing, the position he held at the time of his present appointment.

R. Conrad Cooper was named vice president, administration planning, of U. S. Steel Corp. Mr. Cooper, who has served as vice president, industrial engineering since 1948, will assist in the development and applica-



JOHN E. ANGLE

tion of over-all programs and policies. At the same time, **John E. Angle,** presently general superintendent, Gary Sheet and Tin Mill was named vice president, industrial engineering, succeeding Mr. Cooper. From 1937 to 1945 Mr. Cooper was with Wheeling Steel Corp., serving in several capacities including assistant vice president in charge of operations. He joined U. S. Steel in 1945 as assistant vice president, industrial relations. Mr. Angle began his career at the Gary Sheet and Tin Mill in 1932 as a junior metallurgist. Two years later he became turn foreman in the cold reduction mill. In 1936 he became assistant superintendent of the mill's sheet division, and advanced to superintendent of the division in 1939. He was named assistant general superintendent in 1944, and in 1952 became general superintendent.

Darwyn I. Brown has joined the staff of Washington Steel Corp. as assistant to the president. Mr. Brown started his industrial career with Youngstown Sheet & Tube Co. in 1934. He worked for Carnegie-Illinois

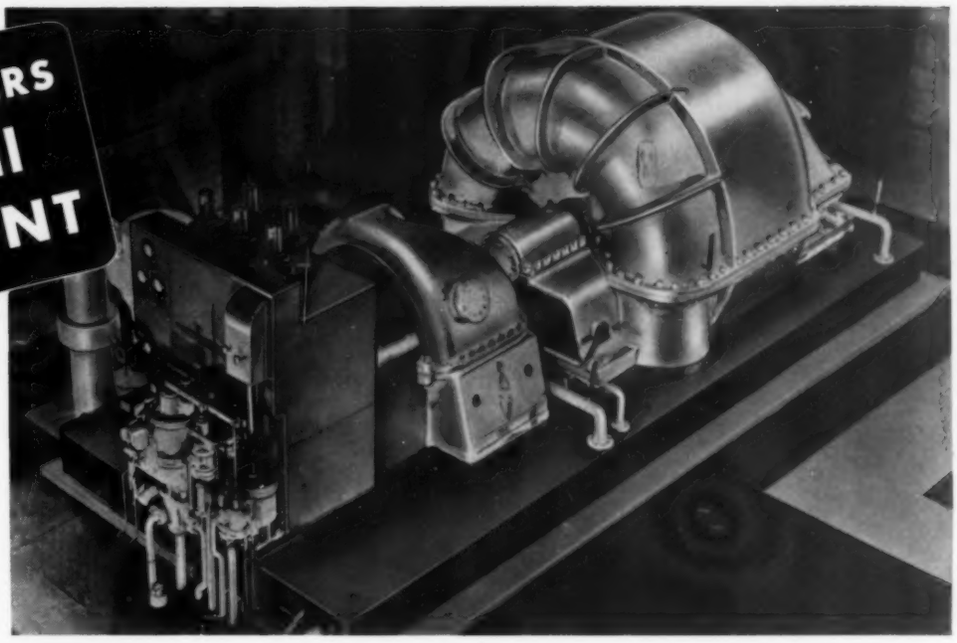
DARWYN I. BROWN

Steel Co. in Youngstown and the U. S. Steel Research Laboratory in Kearney, N. J., before being named metallurgical contact representative for U. S. Steel Alloy Bureau in Pittsburgh. In 1946, Mr. Brown became Chicago editor of Iron Age. Four years later he moved to New York as metallurgical editor and later was technical editor of the publication. In 1953, he joined Mullins Mfg. Co. of Salem, Ohio, as manager of market development and remained in that position until coming to Washington Steel.

Neil Franklin Meredith has been appointed production manager at the Maple Grove, Ohio, Works of Basic Refractories, Inc.

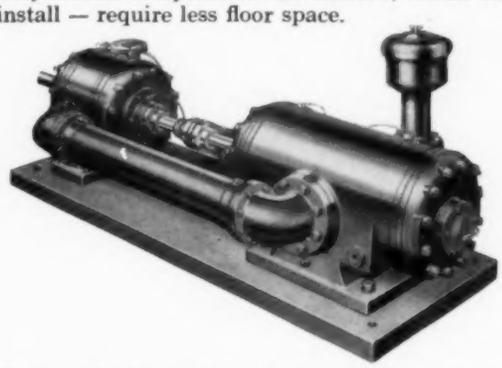
Top Efficiency Compressors For *ANY* Steel Mill Duty

ALLIS-CHALMERS Steel Mill EQUIPMENT



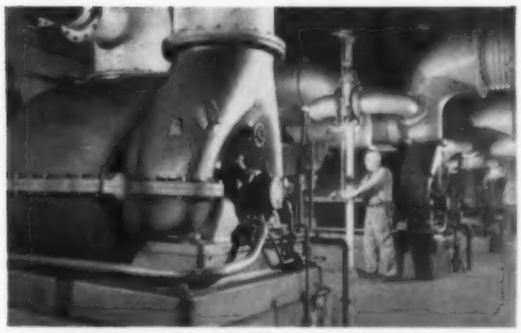
Blast Furnace Blowers — Allis-Chalmers manufactures a complete line of centrifugal units for blast furnaces. The 75,000-cfm, 30-psig blower shown at right, placed in operation in 1942, is driven by an Allis-Chalmers 8500-hp steam turbine.

Allis-Chalmers also builds a wide range of axial compressors for high efficiency blast furnace duty. Axial compressors are smaller, easier to install — require less floor space.



Plant Air Supply — Two-stage *Ro-Flo* compressor delivers plant air supply with constant efficiency; cuts maintenance requirements. If wear occurs, it automatically compensates for itself so that air supply is unaffected.

From Blast Furnace to Plant Air, Allis-Chalmers Compressors Give High Efficiency at Lowest Installation and Operating Costs



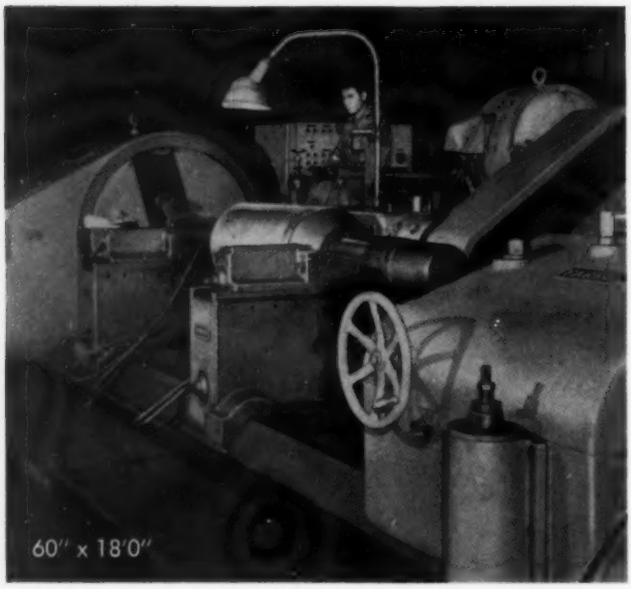
Coke Oven Blowers — Allis-Chalmers centrifugal types are recommended for booster, exhauster, or combination booster-exhauster service. Photograph shows four 23,000-cfm, 5100-rpm, 3.5-psig exhausting blowers in a western steel mill.

Allis-Chalmers has had wide experience building and applying compressors of all sizes and types. For help with your air and gas handling problems, call the A-C office in your district, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

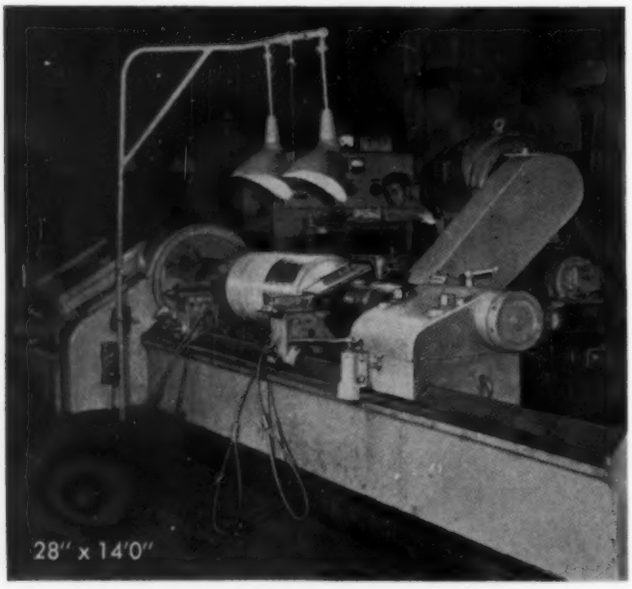
A-4865

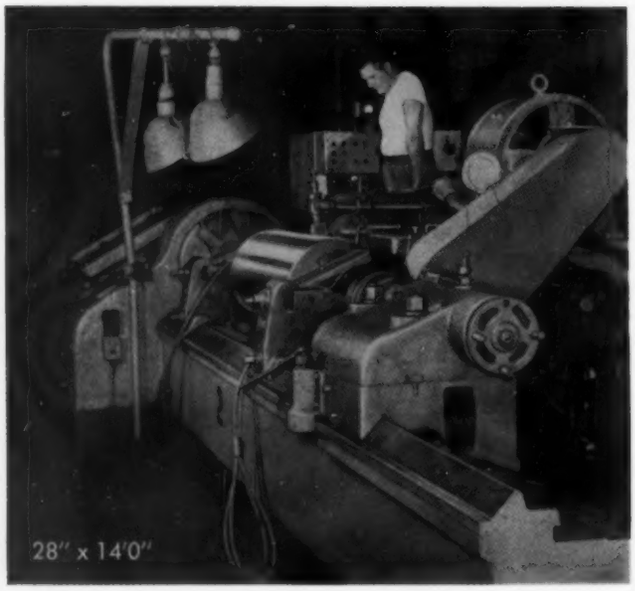
Ro-Flo is an Allis-Chalmers trademark.

ALLIS-CHALMERS



They have taken the "GRIND" out of roll grinding at the Aliquippa works of J&L





Drudgery takes a back seat in roll grinding at Jones & Laughlin's Aliquippa Works.

The three Farrel® heavy duty grinders they have are easy to set up, easy to operate, and the required accuracy—whatever it may be—is easy to obtain.

For example: The spindle assembly, including bearings and drive, is designed to give the grinding wheel extremely smooth and accurate performance, when either roughing or finishing. The spindle itself is large in diameter for necessary rigidity under working load.

For example: The automatic crowning device, which grinds a mathematically accurate curve, is simply and quickly set, and requires no manipulation during operation. The same setting produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

For example: Carriage traverse is reversed electrically, automatically, and dwell can be set for any elapsed time required.

These are only three of the features which take the "grind" out of the operation of Farrel roll grinders. For the full story, send for descriptive bulletin.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Akron, Pittsburgh, Chicago, Fayetteville (N. C.), Los Angeles, Houston

FARREL ROLLING MILL MACHINERY

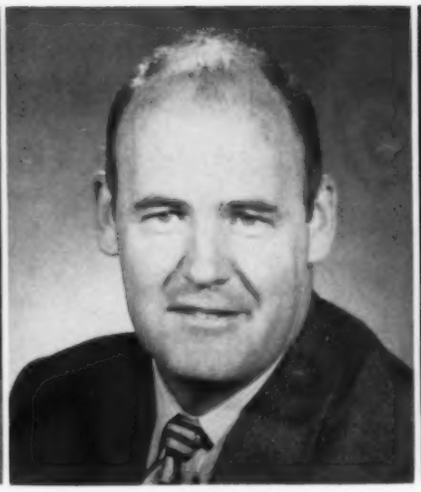
Rolls • Rolling Mills • Rod Mill Tables and Manipulating Equipment • Universal Mill Spindles • Rod Coilers • Slitters • Gears • Mill Pinions • Pinion Stands • Gear Drives of Any Capacity • Flexible Couplings • Roll Grinding Machines • Roll Calipers

FB-1047

Farrel-Birmingham®

H. A. BARTLING

W. E. GUTZWILLER



D. B. SCOTT

NEAL J. CRAIN

H. A. Bartling, formerly manager of Allis-Chalmers Manufacturing Co.'s electronics section, has been named assistant to the director of electrical engineering. **W. E. Gutzwiller** has been appointed successor to Mr. Bartling as manager of the electronics section and **D. B. Scott** has been named assistant manager of the section.

Neal J. Crain was elected to the position of vice president in charge of purchases of United Engineering and Foundry Co. **John H. Lucas** and **Joseph E. Dickinson** were appointed to fill vacancies on the board of directors of the United Engineering and Foundry Co.

John W. Rogers, in addition to his duties as sales manager, has been appointed director of sales and engineering of Wean Equipment Corp. Also, **Albert J. Sarka** has been named chief development engineer and **Kenneth R. Keska** has been appointed chief engineer. In addition, **William P. Donald** has been named assistant chief engineer, design, and **Donald H. Turk** has been appointed chief design engineer.

E. B. Fitzgerald was appointed division manager, responsible for the sale of Cutler-Hammer, Inc., mill and heavy industry control, mill brakes, magnetic clutches and lifting magnets. Mr. Fitzgerald began work for Cutler-Hammer in the company's development department in 1946. Later he worked in the firm's purchasing and engineering departments and in 1949 transferred to the headquarters sales department.

J. H. (Jock) Sutherland was appointed district manager of the Chicago district office of SKF Industries, Inc. Mr. Sutherland previously was field engineer for the SKF Pittsburgh district office. **Ralph E. Campbell** was appointed district manager of the Pittsburgh office. Succeeding Mr. Campbell as field engineer for the district is **Holton E. Fox.**

Vincent V. Tivy was recently appointed the Foxboro Co.'s chief application engineer, responsible for coordinating sales engineering with product development and production engineering activities.

James H. Bechtold, advisory metallurgist in the metallurgy department of the Westinghouse Research Laboratories, has been named manager of that department.

Robert Hartenstein has been appointed chief engineer at Mannesmann-Meer Engineering and Construction Co. Mr. Hartenstein's background of approximately twenty years in the engineering field has included top-level engineering administrative positions with Michigan Seamless Tube Co., Consolidated Machine Builders, Inc., Aetna-Standard Engineering Co. and Youngstown Welding & Engineering Co.

ROBERT HARTENSTEIN

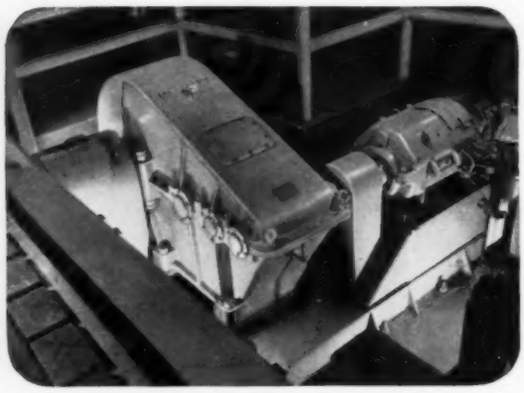
William R. Heath, vice president—manufacturing of Buffalo Forge Co., was elected executive vice president. **George P. Schivley** was made director of manufacturing.

F. P. Spruance, Jr., was elected a vice president of American Chemical Paint Co., and was made sales manager of its metalworking chemicals division. He succeeds **F. P. Spruance, Sr.,** who continues with the firm as a director and a part time advisor and consultant.

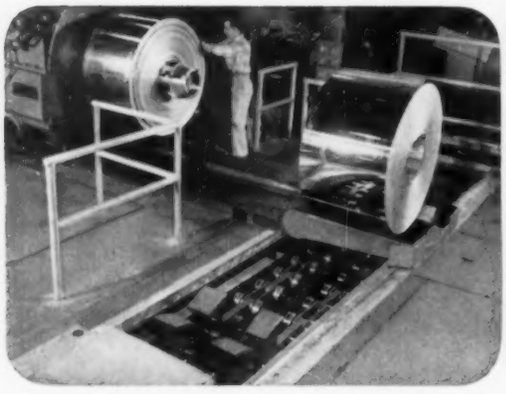
How LINK-BELT serves J & L

AT PITTSBURGH

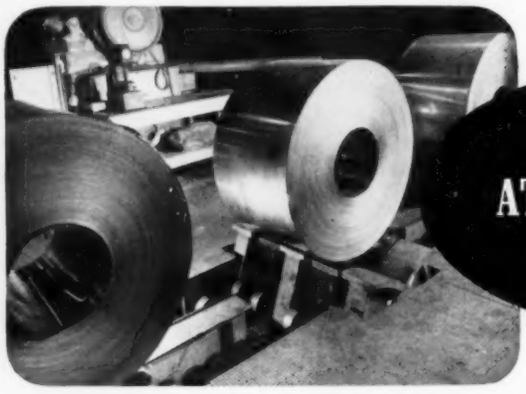
This double-strand Link-Belt coil conveyor, one of two at Pittsburgh works, easily handles coils weighing up to 60,000 pounds.



Parallel shaft drive provides efficient speed reduction. Jones & Laughlin relies on Link-Belt equipment throughout their mills.



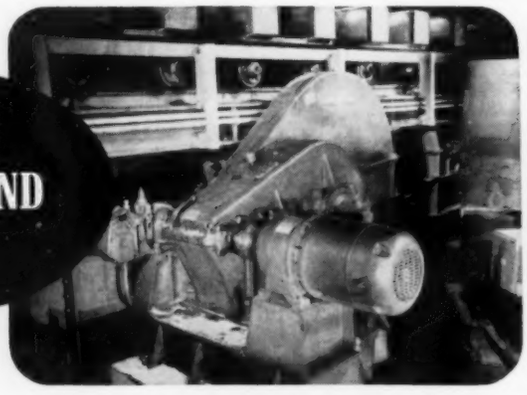
At entry to shear line, up to 72-in. coils are lifted from Link-Belt saddle-top conveyor to pay-off reel by hydraulic buggy.



AT ALIQUIPPA

Precise weights of up to 40,000-lb. coils are recorded as they move along Link-Belt conveyor at temper mill delivery end.

AT CLEVELAND



Booster drive at J & L's Cleveland works includes Link-Belt Electrofluid, parallel shaft gear and precision steel roller chain drives.

Yield goes up, waste goes down on the 77-in. hot strip mill served by Link-Belt car-type conveyor. Coils are moved gently, safely.

AT ALIQUIPPA, in addition to the coil conveyors at the shear line and temper mill shown above, Link-Belt equipment serves the cleaning line, continuous pickling line, cold rolling mill, and handles scrap steel. At other J&L mills, Link-Belt conveyors assure economical movement of materials in every step of steel making, from raw materials to finished product. Next time you need a single conveyor or a complete system, call the Link-Belt office near you. We're sure you'll like the expert engineering cooperation promptly available to you.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION EQUIPMENT

13,686-A

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Earl F. Lowe, Jr., has been named general superintendent of Interlake Iron Corp.'s Duluth plant. Mr. Lowe will take the place of **Maurice Webb,** who died October 11. Mr. Lowe has been assistant general superintendent since July 1 and superintendent of coke ovens since 1953.

R. G. Gaw has been appointed manager of the newly-established Pittsburgh office of Western Precipitation Corp. Mr. Gaw spent 13 years in various engineering

R. G. GAW

and executive capacities with the U.S. Steel Corp. in its National Works, Geneva Works, and in other plant operations before joining Western Precipitation.

Gordon Barker was elected vice-chairman of the board of directors of Vanadium-Alloys Steel, Canada, Ltd. **Edward P. Geary** succeeds Mr. Barker as president of the company. Until recently Mr. Barker was executive vice president of Atlas Steels, Ltd.

John K. Stewart, Jr. has been appointed assistant to the president of Industrial Nucleonics Corp. Prior to this recent appointment Mr. Stewart had been associated for the past five years with Bloom Engineering Co.

Kenneth D. Reed has been named manager of the newly-created Lubrication Section of Dravo Corp.'s Machinery Division. Mr. Reed, formerly affiliated with the DeLaval Separator Co. in a similar capacity, joins Dravo as a result of the company's acquisition of the Mill Lubrication Department from DeLaval.

Evans Taylor, former Philadelphia branch sales engineer, has been named manager—sales engineering of Exide Industrial Division of the Electric Storage Battery Co. He succeeds **E. J. Fitzmaurice, Jr.,** who has been appointed Boston branch sales manager.

Harvey Bertrum Wilgus has been appointed general sales manager of the Electric Products Co. He will be responsible for the sales activities in all divisions of the company.

Walter E. Streeter, assistant plant manager at Kaiser Aluminum & Chemical Corp.'s Erie, Pa., Works, has been named plant manager of the forging facility. Mr. Streeter replaces **Frank J. Klima** who has been appointed forging project engineer.

Robert Berg was named chief draftsman of E. W. Bliss Co. and **George Bearer** and **Roger Kilpatrick** were named sales engineers in the Rolling Mill Division. Mr. Berg, prior to joining Bliss, was associated with Republic Steel Corp. for fifteen years as a project engineer. Mr. Bearer was previously with Industrial Nucleonics from 1951 to 1955 and Armco Steel Corp. from 1949 to 1951. Mr. Kilpatrick was formerly associated with Gary Sheet & Tin Co.

A. J. Kingseed has been promoted to assistant general manager of the Farrel-Cheek Steel Co. Other promotions announced are **F. A. Kingseed** to works manager, and **Alton Zimmerman** to assistant works manager.

A. A. Piper, who recently completed his 44th year with The Electric Controller & Manufacturing Co., the last 24 of them as district manager in Chicago, is relinquishing his responsibilities in this connection to become a consultant for the company in the Chicago area. Succeeding him as district manager in Chicago is **M. E. Young,** who has been a member of the Chicago sales staff since 1940.

KENNETH D. REED

EVANS TAYLOR

E. J. FITZMAURICE, JR.

HARVEY B. WILGUS

Lewis W. King, roll department manager, Birdsboro Steel Foundry and Machine Co., was appointed assistant to the vice president—engineering. His duties concern the sale of rolling mill machinery and designing of rolls. **Ralph H. Scholl,** former sales manager of National Roll and Foundry Co., succeeds Mr. King as manager of the roll department.

Jacob J. Jaeger was named vice president and chief engineer of the machine tool division of Pratt and Whitney Co., Inc., and **Albert L. Knapp** was named vice president—manager of the company. **Edward J. Ferris** was made general superintendent to succeed Mr. Knapp.

T. P. Stanton, former assistant manager of the Eastern sales district, Basic Refractories, Inc., has been named to the post of Midwestern district sales manager with headquarters in Gary, Ind. **Thomas R. Lally,** formerly in the company's Pittsburgh office, will assume Mr. Stanton's former position in the Philadelphia office. **T. D. Pence** of the Central sales district will move to the Pittsburgh office, and **Charles A. Greenlee** transfers from a staff position in the Cleveland office to a sales assignment in the Central district.

John W. Alden, chief mill metallurgist of the Timken Roller Bearing Co., retired November 1. Mr. Alden started work with the United States Steel Corp. in 1915, and served successively with the United Alloy Steel Corp., the Central Alloy Steel Corp., the Republic Steel Corp. and Timken.

Jack L. Ziercher has been appointed manager of market research for Harbison-Walker Refractories Co.

JACK L. ZIERCHER

James W. Hughes has been named regional industrial sales manager for the Minneapolis-Honeywell Regulator Co.'s Midwest region, with headquarters in Chicago. **Raymond A. Zack** will become industrial sales manager in the company's Hammond, Ind., branch office, and **Paul R. Sharadin** has been assigned to the new position of regional application engineer for the Southwestern region with headquarters in Dallas, Texas.

AT J & L's ALIQUIPPA WIRE MILL...

34 WELDCO Lightweight Hairpin Hooks Installed 8 Years Ago . . .

. . . And Still On the Job!

At J & L, and in plants and wire mills everywhere, WELDCO Lightweight Hooks are replacing heavy, old-style hooks. For WELDCO Hooks are stronger, lighter in weight, easier to handle, more corrosion-resistant, carry heavier loads (up to 6,000 lbs.) easily and safely. And WELDCO Hooks are built for long, economical service . . . outlast heavy cast hooks 2 to 3 times.

Whether you need conventional pickling hooks or special adaptations, WELDCO engineers design and build to your exact specifications. For complete information and free literature, get in touch with us today.

Corrosion-Resistant . . .
Handle Loads up to 6,000 lbs!

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3801 OAKWOOD AVENUE · · · · YOUNGSTOWN 9, OHIO

CLEVELANDS help speed pipe through J & L annealing furnaces at Aliquippa

OUTSTANDING in the modern equipment of the Jones and Laughlin pipe mill at Aliquippa is this pair of annealing furnaces. Because of a unique "walking beam" construction* which rotates each length of pipe, these furnaces are setting new records for the production of top quality pipe. The "walking beams" in each furnace are motor driven through a hook-up of 3 Cleveland Worm Gear Speed Reducers.

Wherever you go in the Aliquippa plant you'll see Cleveland drives —more than 200 in all—many in use since before World War II. Wherever they serve they deliver dependable performance, just as Clevelands have been doing in other steel mills for over 43 years.

The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

Unique design built and patented (patent pending) by York-Gillespie Mfg. Co. of Pittsburgh. Furnaces designed and built by Rust Furnace Co. of Pittsburgh. Photos by courtesy of Jones & Laughlin Steel Corporation.

William Zatezalo has been named assistant to the manager of the Steel Works Department at Weirton Steel Co. Mr. Zatezalo began his employment with Weirton in 1942 as assistant to the metallurgist in the Quality Control Department. In 1946 he was named assistant senior metallurgist. He later was advanced to senior metallurgist and then to Steel Works metallurgist, the position he held prior to his current appointment.

A. B. Fisher, Jr., has been appointed assistant manager of production in the Engineering and Construction Division of Koppers Co., Inc. In addition, **R. K. Matthews** was named general superintendent of construction, **H. F. Welch** was made assistant general superintendent of construction, and **R. D. Segur** was appointed by-product and chemical superintendent, Operating Department.

Walter Gramm was elected chairman of the board of directors of Great Lakes Carbon Corp. He succeeds the late **George Skakel, Sr.** Elected as a director of the corporation was **James C. Skakel,** who first joined the company in 1943 and has served in various capacities including the office of president of Great Lakes Corp. Mr. Gramm, one of the company's founders, began his career as a salesman for coal producing companies. In 1919 he became a partner in the formation of Great Lakes Coal & Coke Co. That company was incorporated in 1923 and Mr. Gramm became vice president and a director. In 1939, the company was reorganized as Great Lakes Carbon Corp., and in 1947 Mr. Gramm became senior vice president.

John W. Bizot has been appointed to the position of chief metallurgist at Kaiser Aluminum & Chemical Corp.'s Permanente, Calif., foil mill. Mr. Bizot joined Kaiser in 1947 as assistant chief metallurgist at the company's Trentwood, Wash., rolling mill. Since then he has served in a variety of positions, including assistant chief metallurgist at the company's Newark, Ohio, rod, bar, wire and electrical conductor plant and with the electrical product development group set up to promote the use of aluminum alloys for high strength electrical conductor.

J. William Kelly has been appointed sales manager of the Electric Truck Section of Clark Equipment Co.'s Industrial Truck Division. He will direct sales of electric battery-powered fork-lift trucks. For the past two years, Mr. Kelly was sales manager of the Boston branch of the Exide Industrial Division of Electric Storage Battery Co. For the previous seven years he had been a salesman in the company's Atlanta branch, covering the southeast states.

Obituaries

Oliver B. Schmeltz, president and director of the Rees Machinery Co., Inc., died September 18, 1955.

Frank M. Satter, active in the steel industry for the last forty-five years, died September 25, 1955. He had retired from the Midvale Co. in April, 1954. Previously, Mr. Satter was associated with the Youngstown Sheet and Tube Co. and the Bethlehem Steel Corp.

THE ELECTRIC FURNACE CO. Salem, Ohio
EF
Gas Fired, Oil Fired and Electric Furnaces.

HEAT PROCESSING
FURNACES
for the Steel Industry

Equipment for annealing, normalizing, galvanizing and other heat processing of high and low carbon steel, stainless, silicon and other alloys—strip, sheet, wire, tubing and other ferrous and non-ferrous products.

Submit your problems to EF engineers
See our advertisements in preceding and following issues

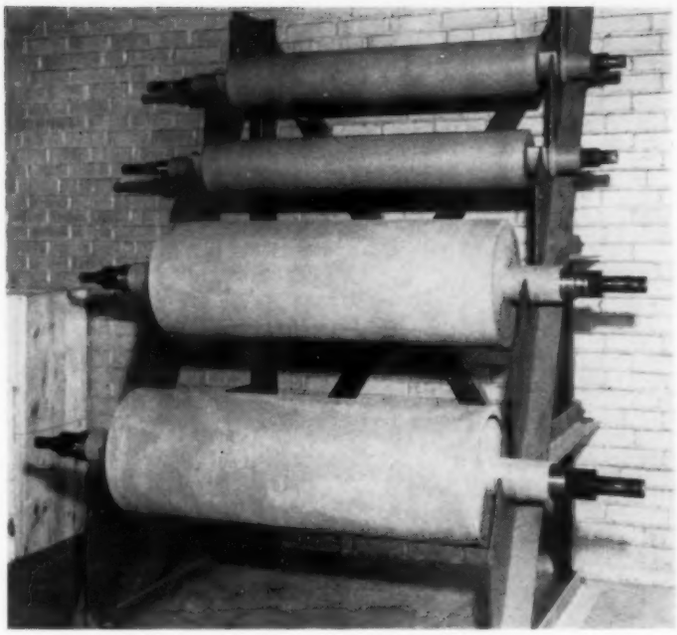
THE ELECTRIC FURNACE CO.
Salem - Ohio
GAS-FIRED, OIL-FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

keep production up with
AIRE-RECTIFIERS
the original Split System
CRANE CAB CONDITIONER
for Crane Cabs and Pulpits
THE LINTERN CORPORATION
ROUTE 20, EAST • PAINESVILLE, OHIO



FOR SCRUBBERS
IN WEAN LINE INSTALLED
IN LARGE EASTERN
TIN MILL
IN
ELECTROLYTIC,
GALVANIZING,
SILICON,
STAINLESS, ETC.

THE
ALL PURPOSE
ROLLS

SPEC

PLASTIC COATED ROLLS

last 3 to 5 times longer than ordinary covered rolls

Special applications require special roll characteristics—acid and moisture resistance, ability to withstand high temperatures, abrasion and friction qualities, etc. SPEC plastic-coated rolls are proving in plant after plant that they do the job better and last three to five times longer.

STRENGTH • DURABILITY • LIFE
never before achieved in covered rolls

Switch to SPEC rolls for reduced downtime—lower maintenance cost—increased production. Made with a variety of different characteristics to meet specific conditions. WRITE, WIRE or PHONE for details and applications.

Write us or contact one of these SPEC Representatives for SPECialized Roll Service

T. A. REILLY COMPANY
139 N. Clark St., Chicago 2, Illinois
Phone — Franklin 2-3474

J. E. KIEFER COMPANY
P. O. Box 3193, Youngstown 12, Ohio
Phone — Sterling 2-6386

DeSHAZO-THOMAS
107 Broadway, P. O. Box 5822, Birmingham 9, Ala.
Phones — Tremont 1-4127; Tremont 9-6610

EMPIRE ENG. CO.
385 East Green Street, Pasadena 1, California
Phone — Ryan 1-6178

A. M. McINTYRE
8226 Buchanan Street, St. Louis 14, Missouri
Phone — Harrison 83940

HIGGINSON ENGINEERING CO.
275 James St. North, P. O. Box 23,
Hamilton, Ontario, Canada

THOMAS J. DEMPSEY, JR.
321 Investment Bldg., Pittsburgh 22 Pa.
Phone — Grant 1-8370

STEEL PLANT EQUIPMENT CORP.
Room 50, Curren Arcade Bldg., Norristown, Pa.
Phone — Norristown, Pa. 5-7539

*Steel Plant Equipment Corporation

SPECIALISTS IN COVERED ROLLS

3117 Grant Building — EXpress 1-3277 — Pittsburgh 19, Pa.

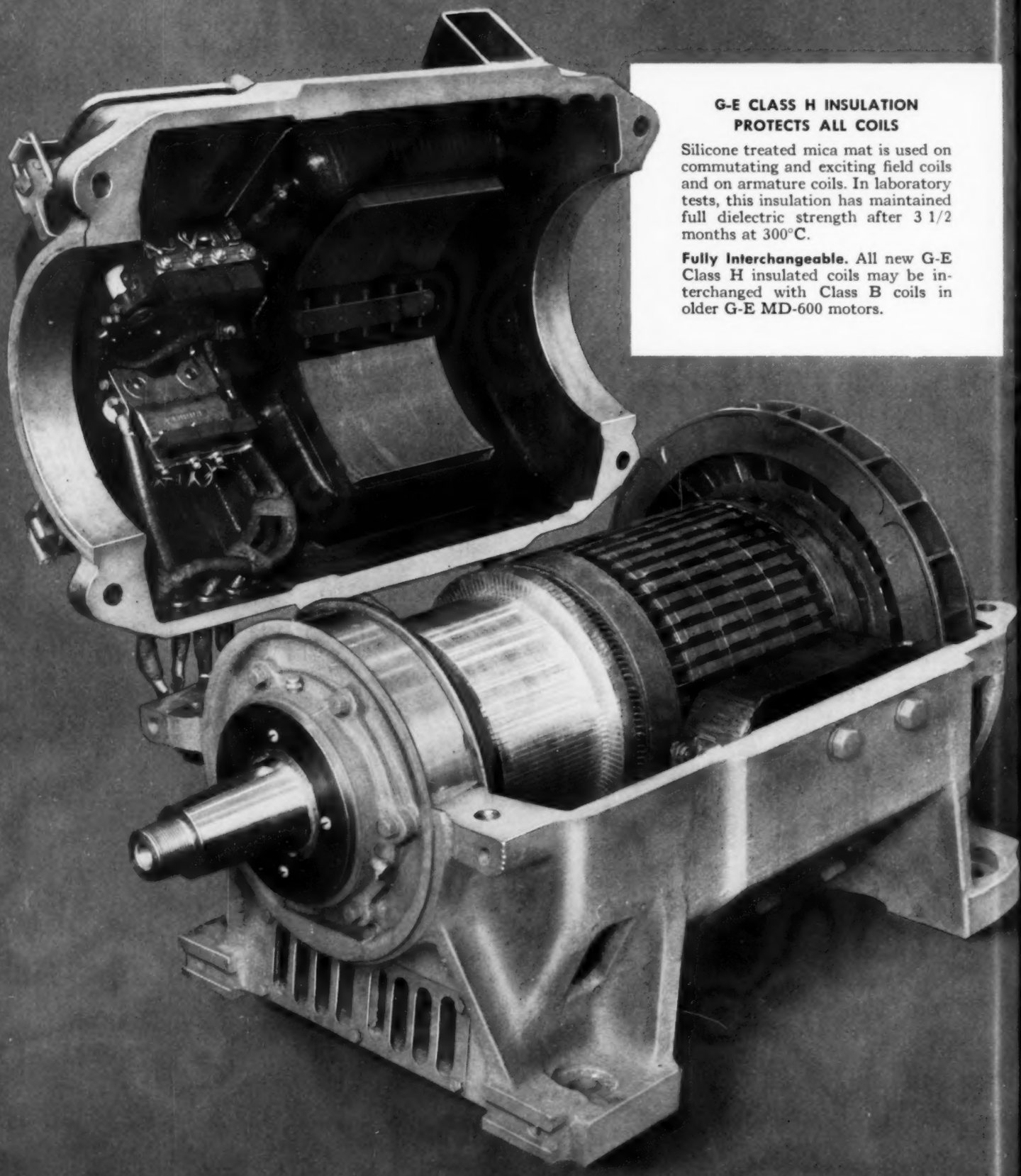
4

ANNEALING • PICKLING • SCRUBBING • FINISHING • ELECTRO-TINNING

PROGRESS IN
DIRECT-CURRENT DRIVES

NOW! Roastouts

NEW G-E MD-600 MOTORS



G-E CLASS H INSULATION PROTECTS ALL COILS

Silicone treated mica mat is used on commutating and exciting field coils and on armature coils. In laboratory tests, this insulation has maintained full dielectric strength after 3 1/2 months at 300°C.

Fully Interchangeable. All new G-E Class H insulated coils may be interchanged with Class B coils in older G-E MD-600 motors.

Virtually Eliminated on . . .

WITH CLASS H INSULATION

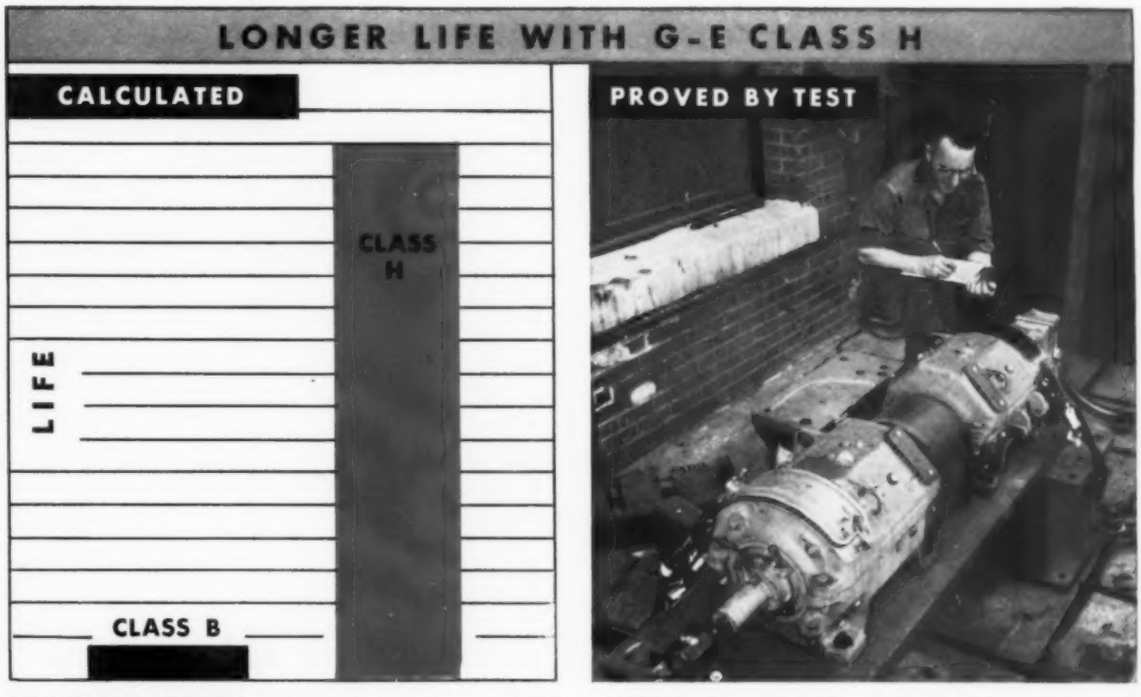
G.E. offers—in all MD-600's—Class H Insulated Coils

WHAT IS CLASS H? General Electric research has developed a combination of inorganic and silicone materials for a new insulation system now used in all MD-600 motors. These Class H materials will withstand temperatures up to 180°C continuously.

BETTER FOR HEAVY DUTY. Auxiliary mill motors often encounter unexpected high ambient temperatures, unforeseen extended duty or emergency conditions. Any one of these can cause "roastouts" from temperatures higher than the insulation capacity. The new G-E Class H insulation will resist up to 50°C more than Class B, resulting in longer motor service.

REWINDS ELIMINATED? On normal duty, insulation failure may be eliminated as the limiting factor in continuous armored motor service. Engineers calculate that each 10°C rise in temperature reduces the life of a given type of insulation by half. *Since G-E Class H will withstand 50°C higher than Class B, its life* **at the same temperature** *should be increased 2^5 or 32 times!*

YOUR G-E SALES REPRESENTATIVE HAS COMPLETE INFORMATION. Contact him at your nearby G-E Apparatus Sales Office, or write Section 812-1, Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.



ENGINEERING STUDIES indicate that under identical operating conditions new G-E Class H insulated coils in MD-600 motors will last up to *32 times* as long as conventional Class B coils. Insulation failure may be eliminated as the limiting factor in continuous auxiliary mill motor service.

ACTUAL TEST with Class H and Class B motors coupled together *proves to date* the new insulation will last more than twice as long as the old. After burning out two Class B insulated motors, the one with Class H coils is still operating under exaggerated load, vibration and atmospheric conditions.

Progress Is Our Most Important Product

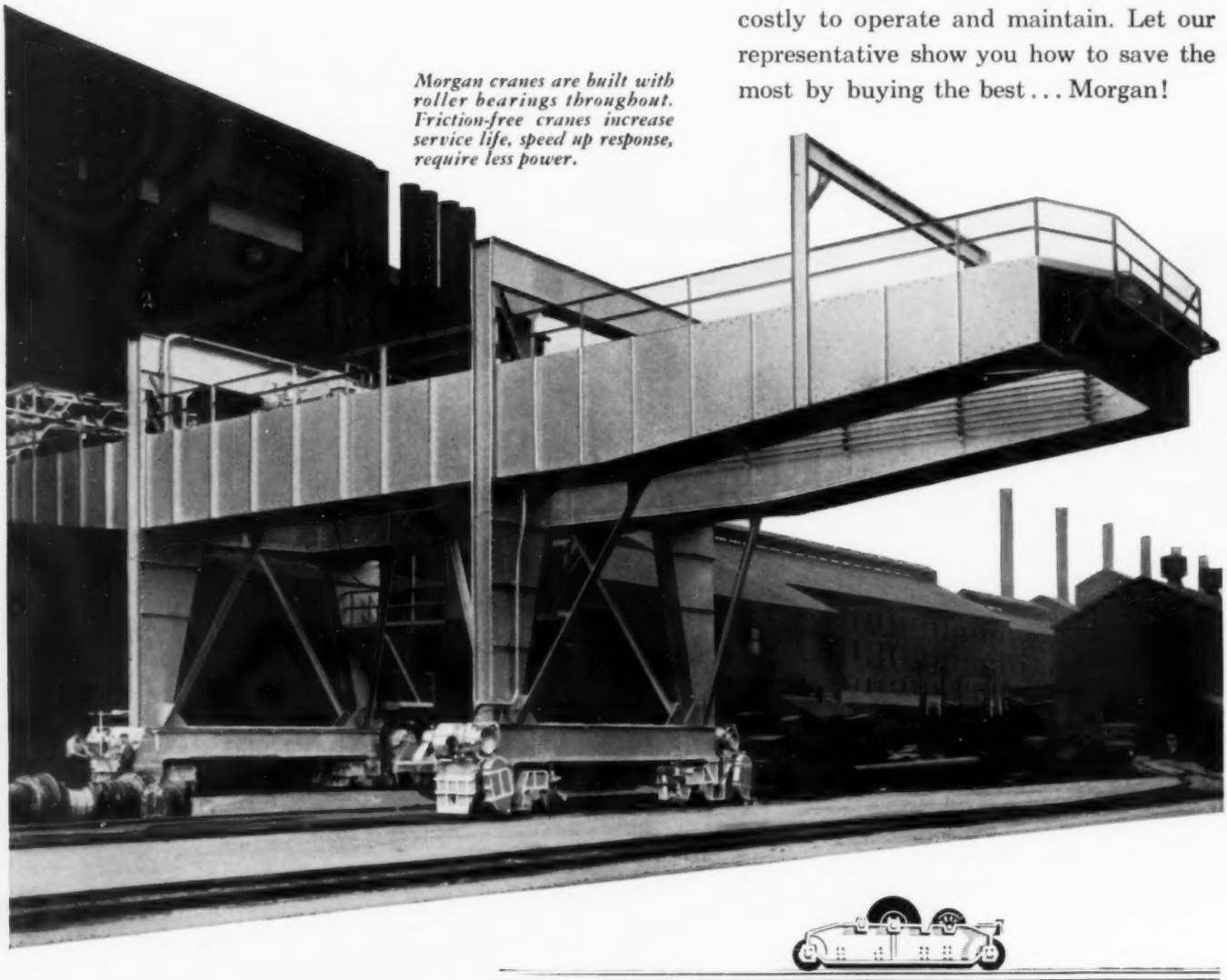
GENERAL ELECTRIC

How Morgan keeps cranes "rolling"

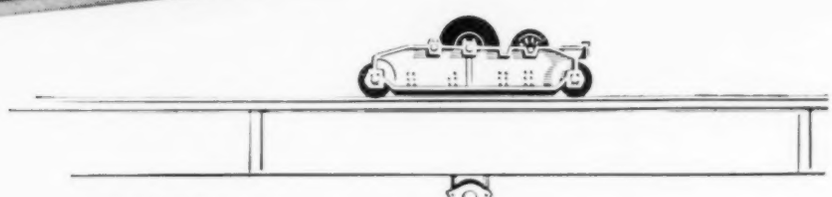
• MORGAN "Anti-Friction Engineering" keeps cranes rolling by providing precisely correct bearings and mountings for each specific application . . . your assurance of longer trouble-free operation, lower maintenance costs.

"Anti-Friction Engineering" is another vital link in the chain of features that makes Morgan cranes best in the business.

Performance records prove that advanced design and heavy-duty construction of Morgan cranes make them less costly to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!

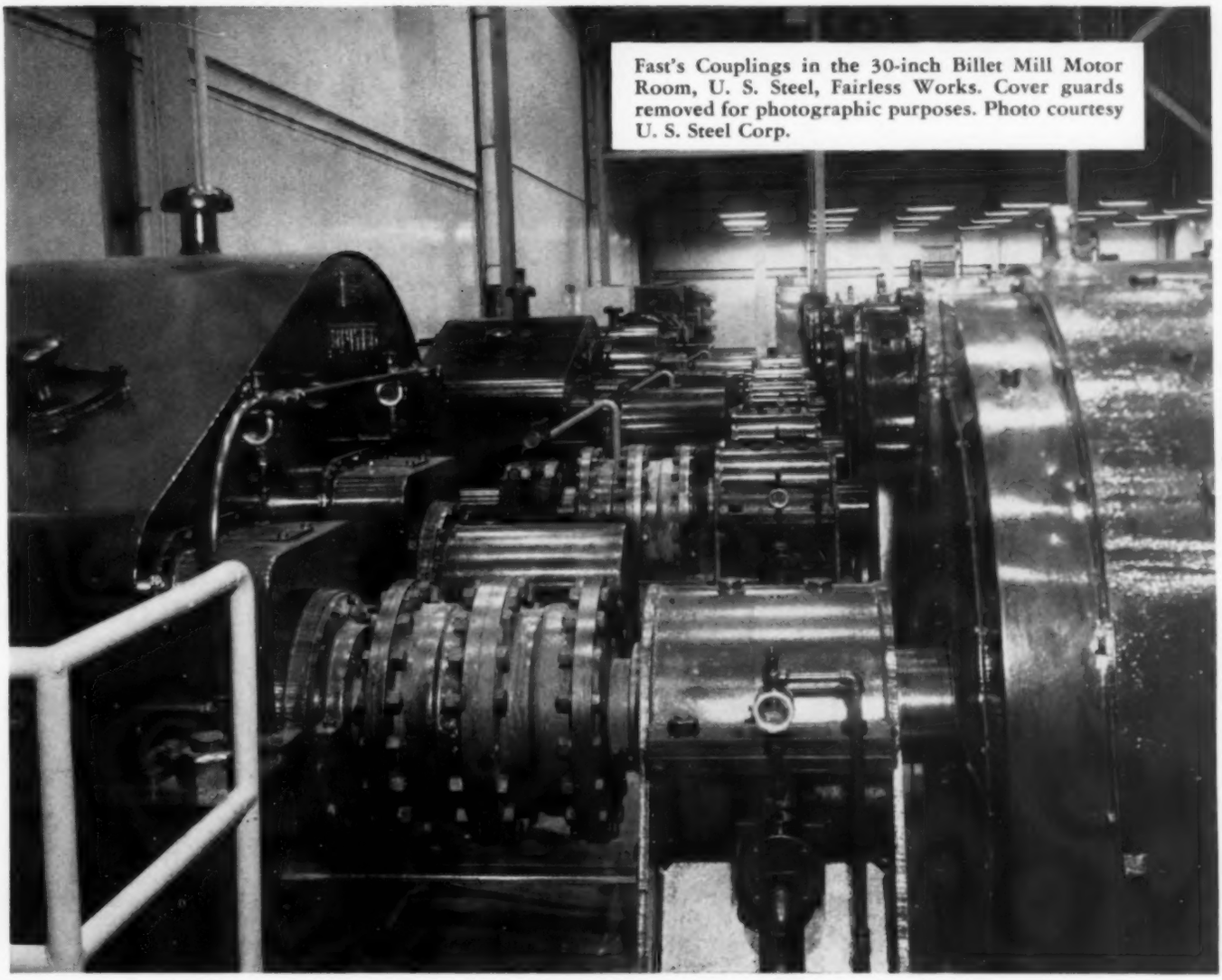


Morgan cranes are built with roller bearings throughout. Friction-free cranes increase service life, speed up response, require less power.



The Morgan Engineering Company manufactures overhead electric traveling cranes, gantry cranes, charging machines, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE MORGAN ENGINEERING CO. *Alliance, Ohio*



Fast's Couplings in the 30-inch Billet Mill Motor Room, U. S. Steel, Fairless Works. Cover guards removed for photographic purposes. Photo courtesy U. S. Steel Corp.

U. S. Steel's Fairless Works equipped with Fast's Couplings

When U. S. Steel equipped its new Fairless Plant they selected Fast's Couplings for installation.

It's no wonder that U. S. Steel specified Fast's. Fast's Couplings have the approval of industry in general everywhere.

Industry finds that Fast's Couplings minimize down-time. Fast's, *the original gear type* couplings, give trouble-free performance. Save on maintenance. Save money (often thousands of dollars in production losses) because there is no down-time due to breakage or expensive replacement of perishable parts.

They also offer the lowest cost per year . . . usually outlast the equipment they connect. Many still in use after 30 years. Why? Because they are ruggedly constructed of the sturdiest, most practical materials . . . all steel in construction, unique in design.

35 years of experience in developing these materials and designs means our staff is well prepared to give you the most effective and cost-saving solutions to your coupling problems. Let Koppers help you. Just write, outlining your requirements. And mail the coupon below for additional general information.

KOPPERS®

THE ORIGINAL

FAST'S Couplings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.
Engineered* Products Sold with *Service

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **311 Scott St., Baltimore 3, Md.**
Gentlemen: Please send me a Free, Fast's Coupling Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name.....

Company.....

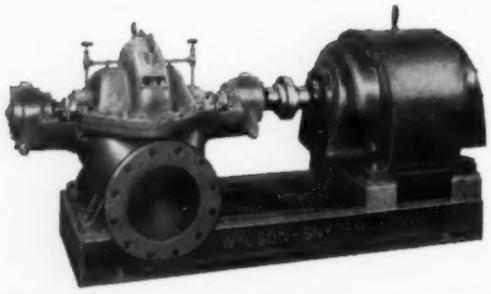
Address.....

City.....Zone.....State.....

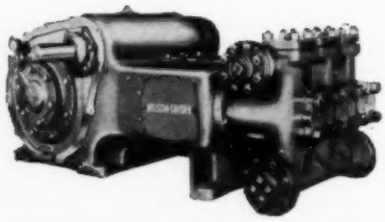
WILSON-SNYDER PUMPS

FOR OVER 75 YEARS

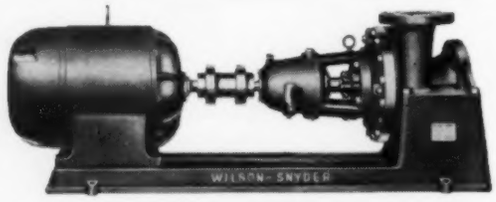
THE SYMBOL OF QUALITY AND DEPENDABILITY



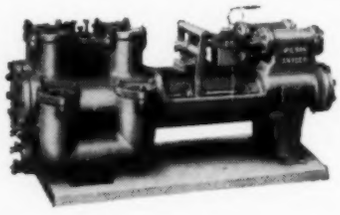
TYPE BA CENTRIFUGAL PUMPS . . . Double-Suction, Single-Stage, Heavy Duty Type with horizontally split case for temperatures up to 250° F.—40 sizes, including double volute cases, provide capacities from 100 to 30,000 gpm, 20 to 750 ft. head, 5 to 1,500 hp—sizes 14" and larger can be furnished with bottom suction and side discharge arrangement.



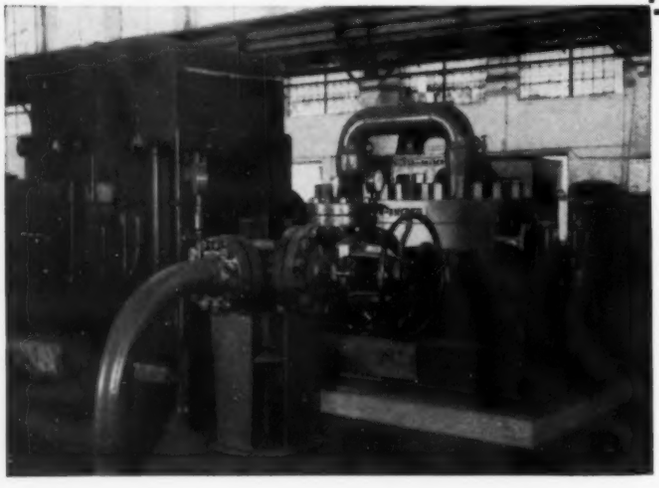
TRIPLEX PLUNGER-TYPE POWER PUMPS . . . for continuous heavy-duty service, designed for handling a wide range of products including highly volatile liquids over a wide temperature range. Available in 4", 6" and 8" stroke sizes for capacity requirements up to 300 gpm and pressures up to 5,650 psi.



TYPE ES CENTRIFUGAL PUMPS . . . single-suction, single-stage, single stuffing box, heavy-duty type with vertically split case, applied for elevated temperatures up to 900°F.—20 sizes provide capacities from 15 to 2,000 gpm, 50 to 1,100 ft. head, 2 to 250 hp—for pressures to 750 psi. Available with mechanical seal, if preferred.



DUPLEX PISTON-TYPE DIRECT-ACTING PUMPS . . . for all general service requirements including handling of volatile liquids over a wide temperature range. Available in stroke lengths from 6" to 24", for capacity requirements up to 1,800 gpm and pressures up to 1,500 psi.



TYPE MB CENTRIFUGAL PUMPS . . . Opposed impeller design and staggered volutes provide inherent hydraulic and radial balance. For high pressures and temperatures up to 300° F.—sizes range from 2" to 6" discharge connection providing capacities from 100 to 1,500 gpm, pressures from 150 to 1,400 psi involving horsepower up to 1,750.

Our vast experience in the design and manufacture of pumps for an extremely wide range of steel mill and metal working applications qualifies us to design and build pumps to satisfy your most exacting requirements.

WILSON-SNYDER WORKS, Braddock, Pa.
OIL WELL SUPPLY DIVISION
UNITED STATES STEEL CORPORATION

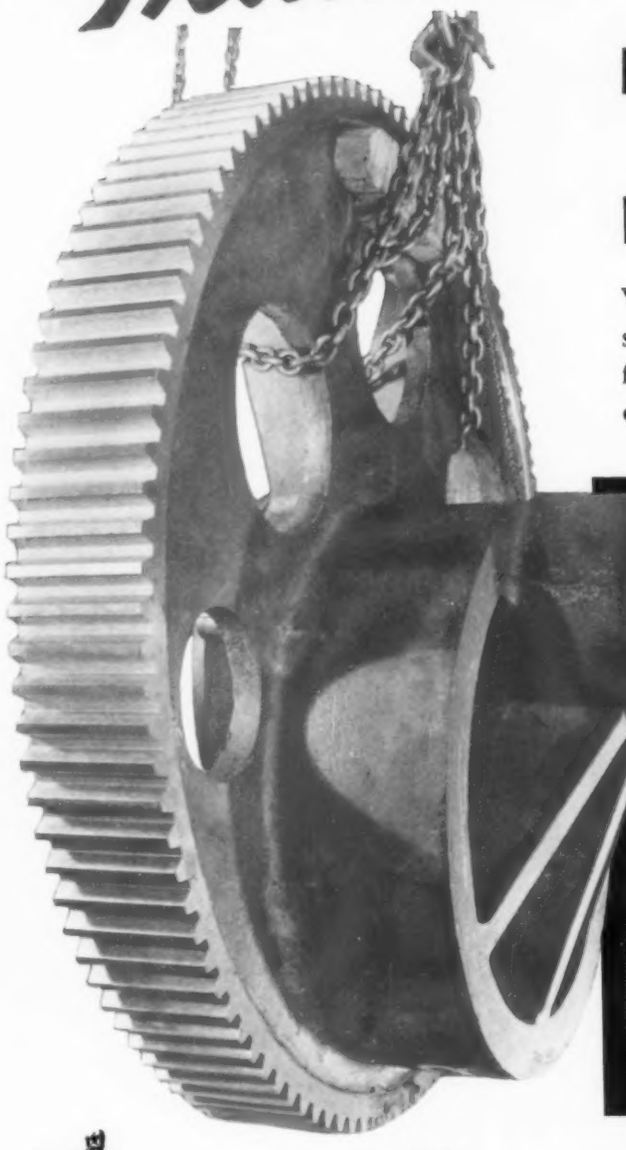
Write for Catalog containing complete specifications on

WILSON-SNYDER PUMPS

and let us quote on your requirements

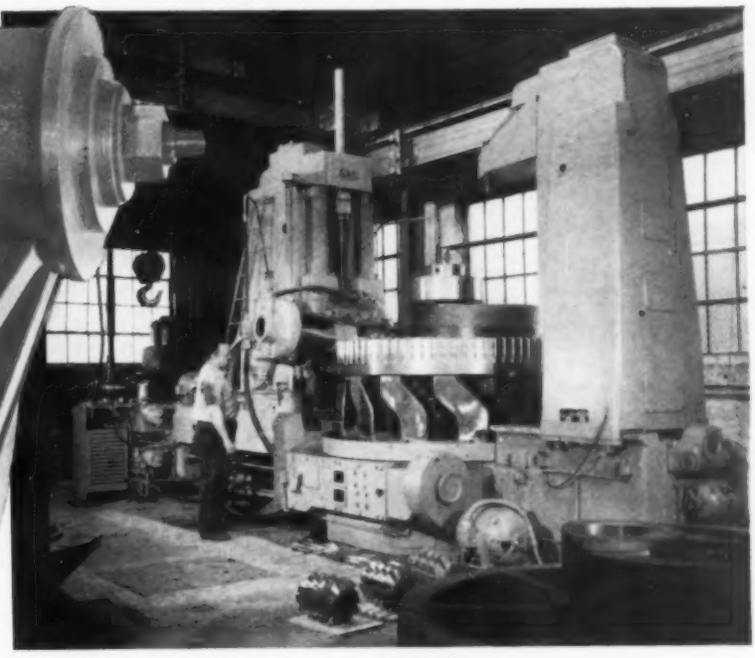
UNITED STATES STEEL

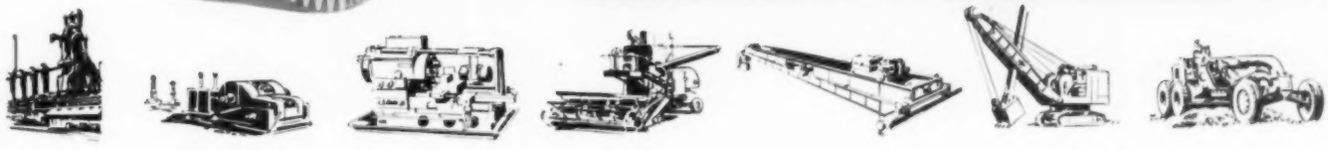
"Industrial Gear"



BIG HOBBER READY TO CUT YOUR HEAVY-DUTY GEARS

We operate day and night to give you the kind of service you need. Our plant is equipped with the finest and most up-to-date machines for the cutting of any type gear.





IG GEARS — INDUSTRIAL GEAR MFG. CO. — SERVE INDUSTRY

DUROCASE GEARS — CASE HARDENED STEEL GEARS

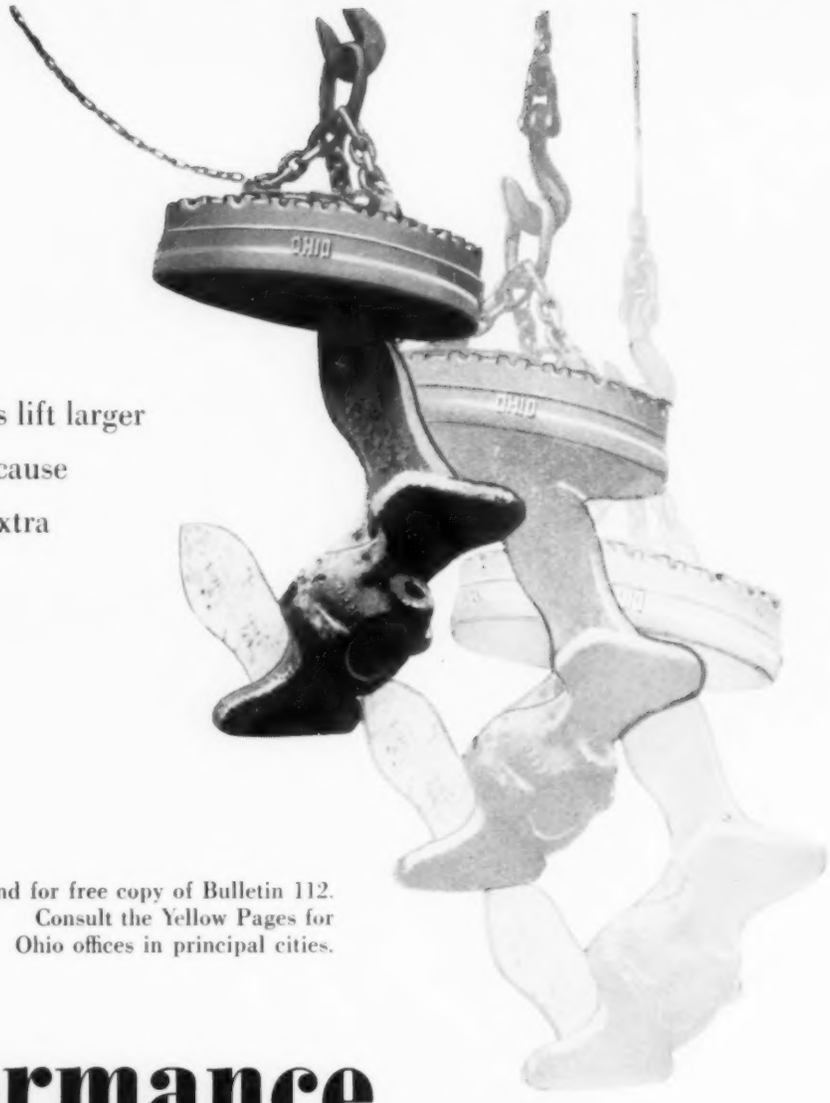
Our plant, devoted exclusively to gear and sprocket cutting, can be visited pictorially. Write for Brochure showing the vast assemblage of equipment ready to serve you.

Let us go over your gear needs with you or send us your blue prints for a trial run.

MEMBER OF AGMA

Industrial Gear Mfg. Co.

4527 W. VAN BUREN ST.
CHICAGO 24, ILLINOIS



Size for size, Ohio Magnets lift larger loads over longer periods because they *operate cooler*. So for extra magnet lifting power, extra magnet value—always specify Ohio Magnets and Ohio Magnet Controllers. There's a type and size for every lifting job.

Send for free copy of Bulletin 112.
Consult the Yellow Pages for
Ohio offices in principal cities.

for performance . . . it's Ohio Magnets

Ohio Bolted Magnets 12″ to 65″ diameter. 6-coil types in 39″ to 65″; 8-coil in 55″ and 65″. Strap copper coils over 39″. Bolts protected in recessed wells. Also capsule coil over 45″.

Ohio Welded Magnets 39″ to 65″ diameter. Lightweight models in 39″ and 45″. 6-coil types in 46″, 55″, 65″; 8-coil in 55″ and 65″. Welded on top where it can't get dented in. Also capsule coil over 45″.

Ohio Basket Magnets 55″ and 65″ 4-coil, and 65″ 6-coil. For extra heavy-duty service; hefty ears project beyond magnet diameter, ward off damaging blows. No weight carried by bolts. Also capsule coil over 45″.

Ohio also makes
Separation Magnets,
Heavy-Duty Electric Hoists,
Nail Making Machines,
Fractional Horsepower,
Shell and Torque Motors,
Precision Threaded Parts for
Aircraft Engine Manufacturers.

THE OHIO ELECTRIC MFG. CO.
5400 Dunham Rd., Maple Heights • Cleveland, Ohio

ohio ELECTRIC

Chester Bland
President

WHAT'S NEWS AT BRISTOL . . .

Thyratron-operated relay gives you closer control with this Bristol temperature controller

An extremely minute change in the measured quantity (less than 0.003 in. on the scale) is all it takes to close or open the Thyratron-operated relay of Bristol Series 536 indicating Free-Vane® Electronic Pyrometer Controllers.

This positive trigger control action makes it impossible for the relay to flutter or chatter, thus reducing wear on the relay. Other features of this extremely stable, rugged and sensitive instrument include:

MILLIVOLTMETER MECHANISM for greater accuracy with a sensitivity of 15 ohms per millivolt.

NO DRIFT IN SET POINT with changes in ambient temperature, line voltage, or tube characteristics.

EXTRA-WIDE SCALE for close, quick, easy reading.

EASY INSTALLATION AND SERVICING with plug-in components. No routine adjustments needed.

AVAILABLE AS THERMOCOUPLE and radiation pyrometers in ranges up to 4000F for L, H, LH, LOH and LNH control, and for L and H with proportional input.

Write for Bulletin P1248. The Bristol Company, 123 Bristol Road, Waterbury 20, Connecticut. 5 39

BRISTOL'S

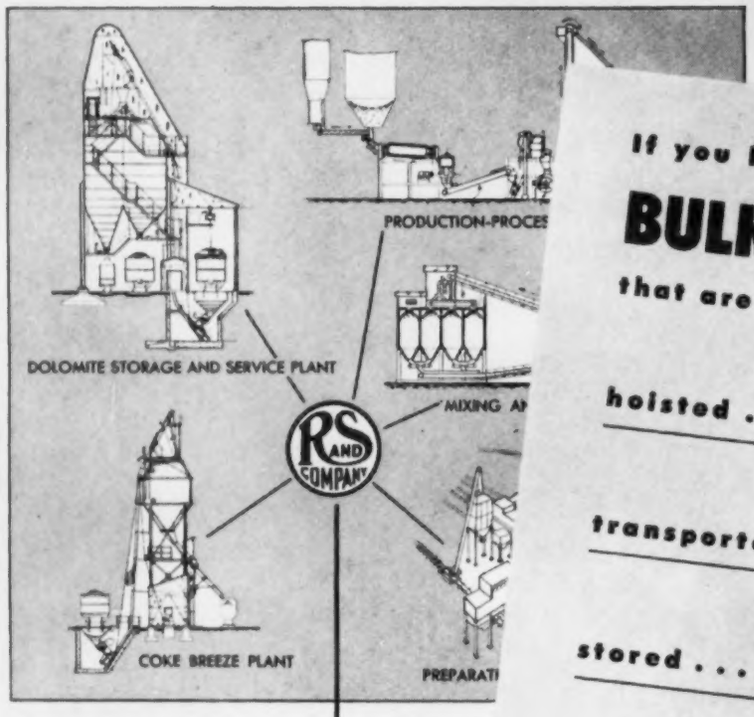
BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

You have seen these before

Designed and built to reduce per ton handling cost



Bulk materials can be handled at reduced cost by properly designed storage and service plants incorporating improved modern equipment.

Roberts & Schaefer Company designs—engineers and constructs—and builds such plants, and has the knowledge and experience to effect greater efficiencies and savings.

If you have bulk materials that are processed, hoisted, transported or stored, R & S complete service can help you. Main and District Offices conveniently located for consultation.

ROBERT
COMPA
130 North Well
Pittsburgh 22,
Huntington 1(
Hibbing, Min
New York 1(

If you have

BULK MATERIALS

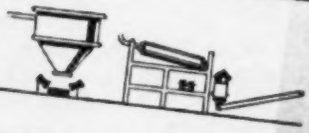
that are.....

hoisted.....

transported...

stored.....

or processed..



Roberts and Schaefer can help you with integrated planning, special design and construction . . . large or small.

Phone, wire or write for consultation. No obligation, of course.

ROBERTS and SCHAEFER COMPANY

Subsidiary of Thompson-Starrett Company, Inc.

ENGINEERS AND BUILDERS

130 North Wells Street, Chicago 6, Illinois

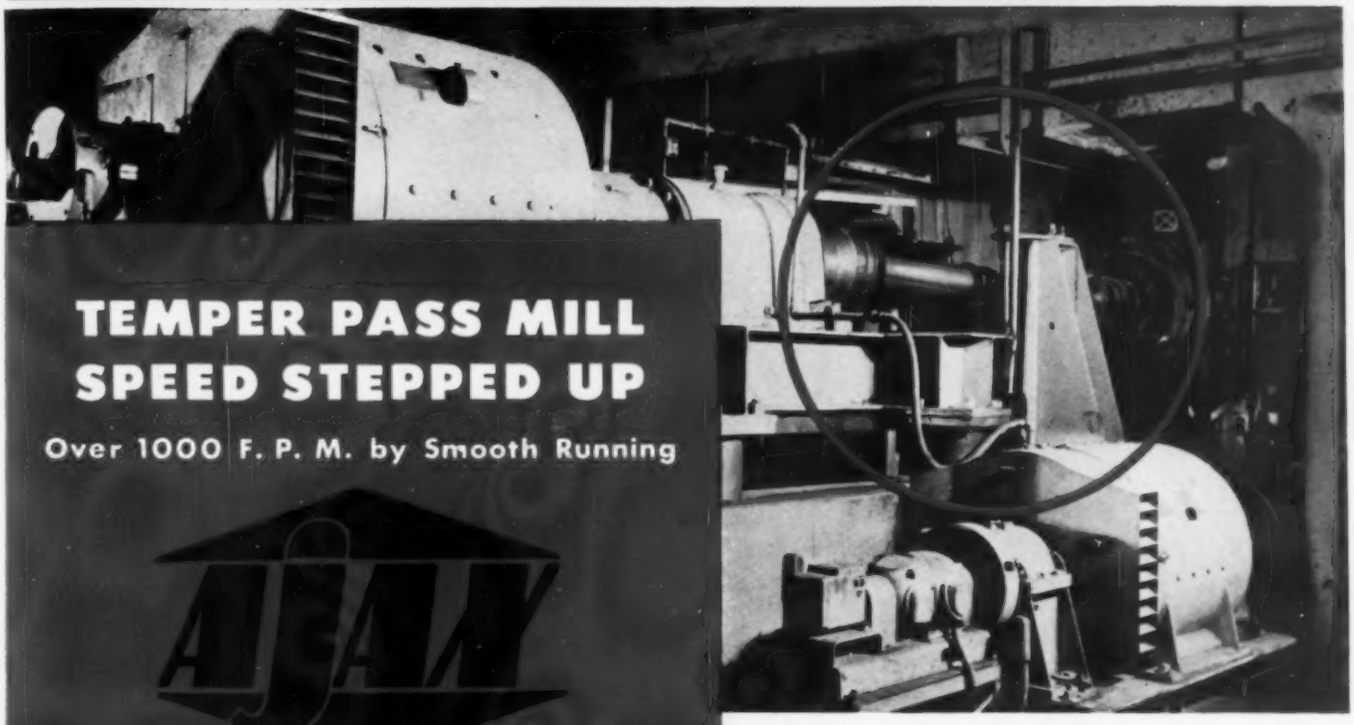
New York 19, N. Y.—254 West 54th Street

Pittsburgh 22, Pa.—1315 Oliver Building

Huntington 9, W.Va.—P.O. Box 370

Hibbing, Minn.—P.O. Box 673

AJAX DIHEDRAL COUPLINGS AT J&L



TEMPER PASS MILL SPEED STEPPED UP

Over 1000 F. P. M. by Smooth Running

AJAX

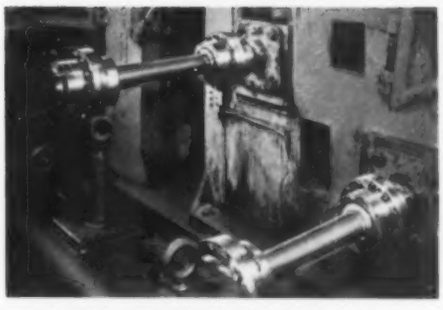
DIHEDRAL SPINDLE SHAFT COUPLINGS

Spindle Drive side of 2-stand tandem tin temper pass mill equipped with Ajax Dihedral Spindle Shaft Couplings designed to transmit 400 H. P. at 400 R. P. M.

THIS photograph shows the first stand of a two-stand tandem tin temper pass mill designed and built by E. W. Bliss Co., for Jones & Laughlin Steel Corporation . . . Aliquippa Works. This mill was designed to be the fastest temper pass mill in the world with operating speeds over a mile a minute. Conventional couplings were replaced by Ajax Dihedral Spindle Shaft Couplings and speed was stepped up over 1000 F. P. M.

This is another dramatic example of how Ajax Dihedral Spindle Shaft Couplings are making all other types of conventional couplings obsolete. Their uniform peripheral speed, ability to handle maximum misalignment with tooth clearance limited to lubrication film requirements, elimination of vibration and minimum maintenance are reasons why mill operators are welcoming Ajax Dihedral Couplings with open arms.

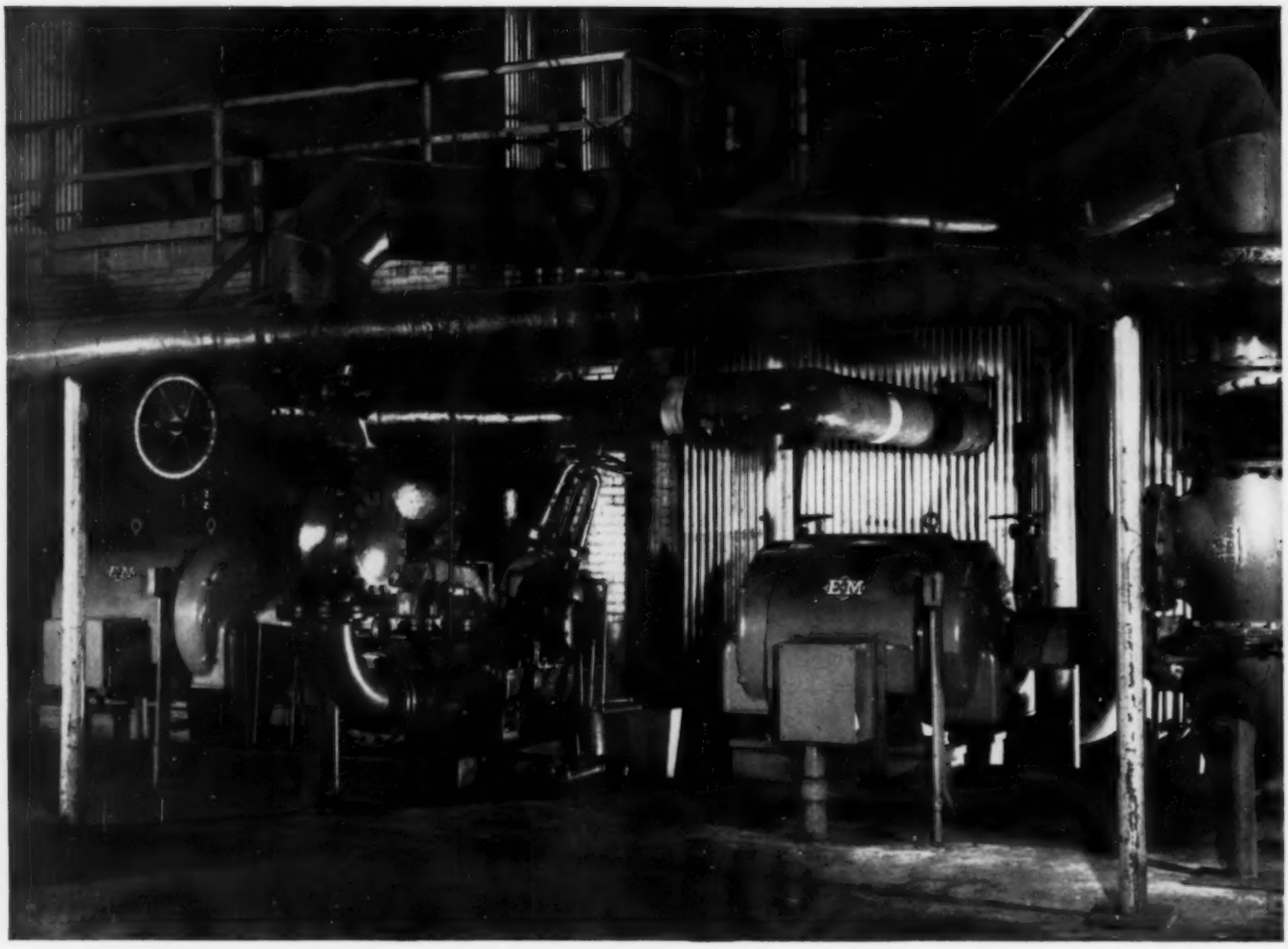
Write for complete data.



The drives on the drag bridles of these #4 cleaners in operation at the Jones & Laughlin Steel Corporation . . . Aliquippa Works, are equipped with Ajax Dihedral Floating Shaft Couplings.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, N. Y.



Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

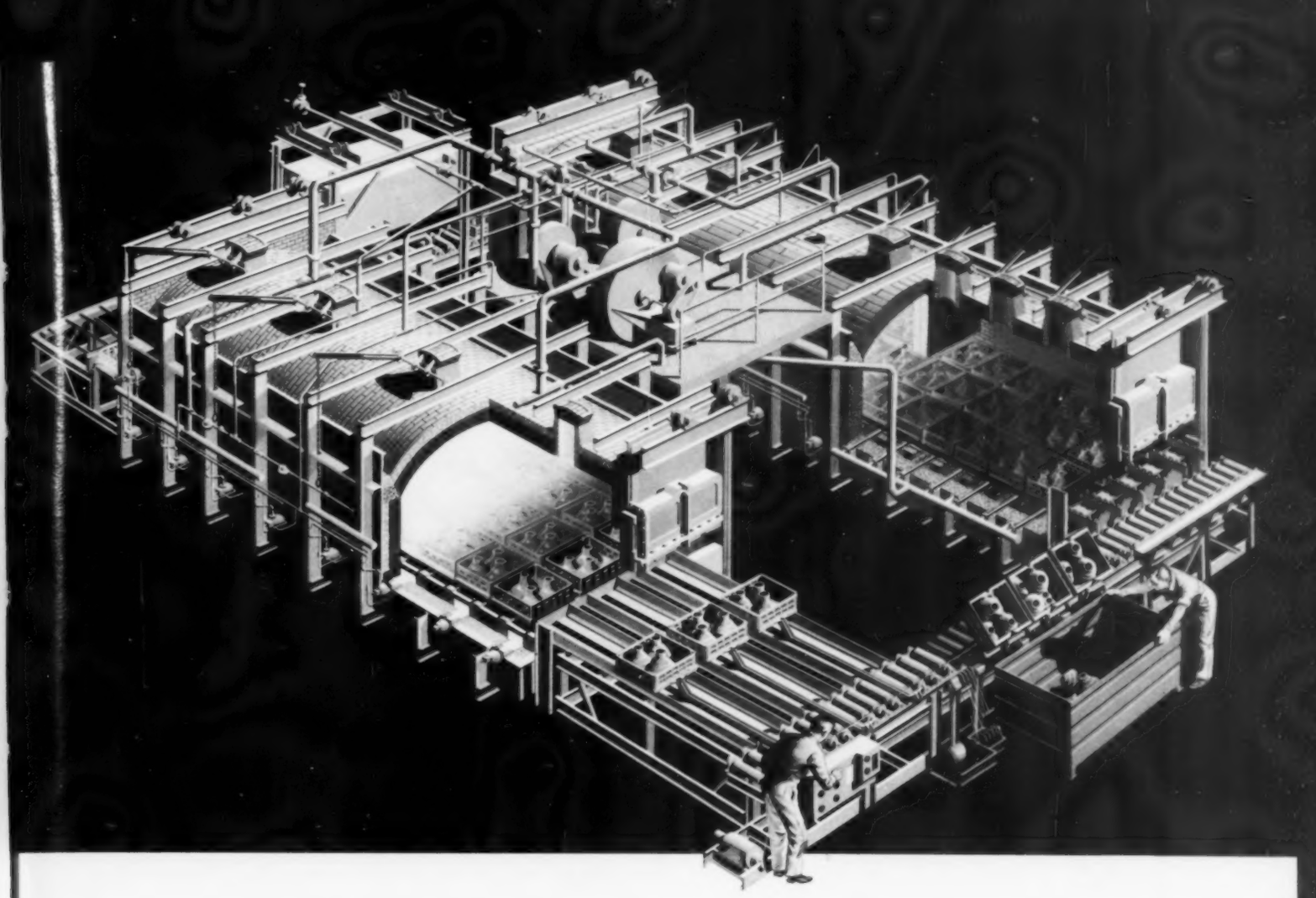
For your next *special* motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Foto-Facts No. 16, showing other modern motor applications in a modern steel mill.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

1300-TPA-2167

Specialists in making motors do **EXACTLY WHAT YOU WANT THEM TO**



You get automatic, precise heat treatment plus high production with this Salem-Brosius furnace

You speed production—control heat treating cycles to close limits—achieve specified metallurgical and physical properties in forged parts with this Salem-Brosius furnace.

This is possible because time, temperature and material movement are automatically controlled to provide precise cycle annealing practice. Rugged construction and simplified design give you efficient operation with low maintenance.

Here is a typical cycle. Forged alloy steel automotive parts, such as clutch plates and drive pinions, are loaded into three trays and positioned in front of the furnace pusher on the left. The furnace takes over.

The trays move automatically into the heat and soak chamber where the parts are heated to 1700°F. and held at that temperature for a timed interval. Then they move to the next section and are control-cooled to 1200°F. at which moment they move to the final zone and are control-cooled to 500°F. At this time the trays are ejected to a transfer table from which they are automatically emptied into tote boxes.

An ingenious arrangement of recording controllers, fuel regulators, thermocouples, and air control valves automatically hold the temperature to within extremely close limits. Yet this precise furnace anneals as much as 4000 pounds of forgings per hour.

This furnace is typical of the efficient heat treating and heating furnaces designed and built by Salem-Brosius to increase your production and reduce your unit costs. The skill and experience of Salem-Brosius engineers recently were augmented by the acquisition of the George J. Hagan Company so that now you get the benefit of the combined abilities of both organizations to design, engineer and build fine furnaces when you specify Salem-Brosius. Write to us!

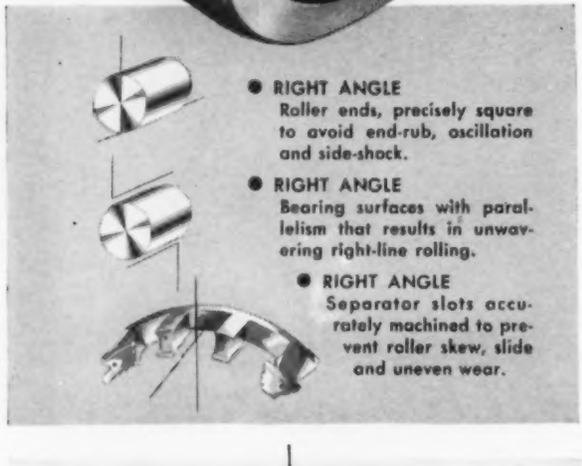
SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

IN CANADA: SALEM ENGINEERING LTD. · 1525 BLOOR STREET WEST, TORONTO 9, ONTARIO

RIGHT ANGLE DESIGN

Reduces Maintenance Costs and Shut-Downs


● RIGHT ANGLE
Roller ends, precisely square to avoid end-rub, oscillation and side-shock.
● RIGHT ANGLE
Bearing surfaces with parallelism that results in unwavering right-line rolling.
● RIGHT ANGLE
Separator slots accurately machined to prevent roller skew, slide and uneven wear.

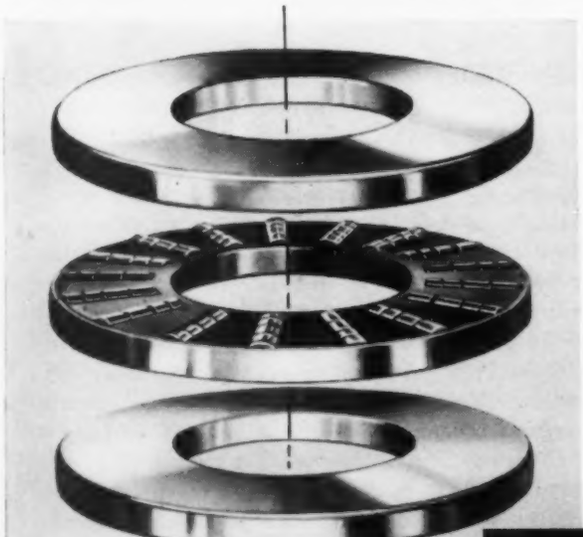
In a Rollway Radial Bearing there's no wedging of the rollers . . . no pinch out . . . far less roller end rub and wear back. Rollway's *Right Angle Design* reduces rubbing friction to a minimum — results in less service attention, longer life expectancy under heavy duty service.

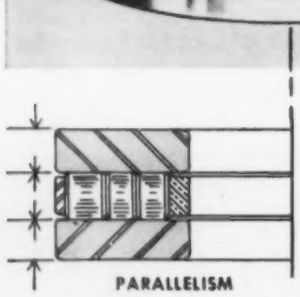
In Thrust Bearing applications, accurate parallelism between the rollers and the matched thrust plates is repeated in the parallelism between the separator slots and the rollers themselves — all adding up to quietness, equalized wear and longer life.

Our complete engineering and metallurgical services will gladly work with you on your problems. Simply write or wire any sales office. No cost. No obligation.

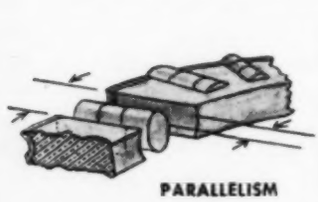
Rollway Bearing replacements are available through authorized bearing distributors in principal cities. Consult your classified 'phone directory.

Rollway Bearing Co., Inc., 569 Seymour St., Syracuse 4, N.Y.





PARALLELISM



PARALLELISM

SALES OFFICES

Syracuse, Boston, Chicago, Detroit, Toronto, Pittsburgh, Cleveland, Milwaukee. Seattle, Houston, Philadelphia, Los Angeles, San Francisco

ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

Publication Service...

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Cold-Roll Forming

A revised edition of Yoder Co.'s booklet, "Cold Roll Forming" is now available. Many new illustrations have been added showing end uses of roll-formed shapes, and the text has been revised and brought up-to-date. The 90-page booklet is designed primarily as a text on the function, scope and economies of cold-roll forming and discusses equipment and processes, end uses of its products, auxiliary equipment for curving, coiling ring-forming, notching, perforating, welding, embossing, and other operations frequently incorporated in cold-forming production lines.

(2) Power Positioners

The complete line of pneumatic power positioners is described in a packet of specification sheets available from Hagan Corp. The packet is a file folder containing six sheets which describe performance and construction specifications for all of the standard positioner models. Sheets cover positioner cylinder sizes ranging from 4 x 5 in. to 12 x 48 in. (Bulletin TP-MFI.)

(3) Cable Insulation

A booklet that establishes performance tests for asbestos insulation applied as a felted wall in combination with varnished cambric tapes for wires and cables with 600 and 1000 volt ratings has been released by Rockbestos Products Corp. This booklet measures the plus values of the felted wall construction over and above industry standards for Type AVA wires and cables. Standards for important test characteristics such as minimum permissible breakdown after initial dielectric test, minimum breakdown during emersion, minimum permissible dielectric strength after bending and surface leakage requirements are covered to make this booklet a complete guide for wire and cable specifiers. (RSS No. 88.)

(4) Heat Absorption

A simplified method by which the heating rate of steel can be calculated and the center temperature of the piece predicted is the subject of a booklet being distributed by Bloom Engineering Co. Entitled, "The Rate of Heat Absorption of Steel," this 32-page booklet includes 15 charts and diagrams for practical use.

(5) Refractories

An illustrated 12-page booklet just issued by Johns-Manville Corp. describes the manufacturing methods used to produce hydraulic-setting refractories for services through 3000 F. How and where to use the five different types of refractories for castables is also described. The three types of refractories for gunning and slap troweling are similarly presented. The booklet also contains up-to-date tables on the properties.

(6) Annealing

High convection annealing of steel strip coils is the subject of a catalog issued by Lee Wilson Engineering Co., Inc. The eight-page booklet illustrates and describes annealing installations in different steel plants, and discusses the features of their single stack furnaces. (Bulletin LW-855)

(7) Presses

Recently published by Baldwin-Lima-Hamilton Corp., is a bulletin that illustrates and describes the company's line of metalworking presses for extrusion, metal forming and drawing, forging, bending, flanging, crimping and straightening, and pipe fabricating equipment. The 12-page booklet explains the broad range of applications of these presses with typical installation illustrations and individual tables of specifications. Also included is a table showing capacities for press rams from one in. to 60 in. in diameter at various hydraulic pressures, the quantity of hydraulic fluid required per in. and ft of ram travel, and pump hp requirements per gallon per minute. (Bulletin 3201)

(8) Clamshell Bucket Operation

Practical help for clamshell bucket operators is graphically presented in a new bulletin issued by Blaw-Knox Co. It contains 40 pages of illustrations and carefully indexed information including: how to use counterweights for maximum efficiency; when to increase or decrease bucket reeving; what makes bucket lips bend in or bow out; cable life, as influenced by sheave diameters, or proper application of tag line, or application to crane, etc; welding procedures for building up worn cutting lips, repairing fractures, etc. in high carbon plate, and cast alloy steel; and numerous other items. A list of common abuses leading to early bucket failure and proper lubrication practices is also included. (Bulletin No. 2373-R)

(9) Pyrometer

A new bulletin, entitled "Photoswitch Photoelectric Pyrometer" has been made available to industry by Photoswitch Division, Electronics Corp. of America. This four page, illustrated pamphlet contains descriptive data, specifications and dimensions on photoelectric pyrometer Type P2T. The bulletin describes how the pyrometer, which operates over a range of from 1000 to 5000 F, will respond to temperature changes of 5 F, indicating this change on a meter and providing relay action to give a signal or to control heating devices. (Bulletin PT 556)

(10) Lubricants

Published by the Alpha Molykote Corp. is a four-page catalog on the variety of "Molykote" lubricants now available. The bulletin, an up-to-date revision, lists seven-

teen types of this molybdenum disulfide lubricant line and features a complete explanation, with diagrams, of the importance of this compound in extreme bearing pressure, and high, low and normal temperature lubrication applications. Five new lubricants are included. The highlight of the bulletin is a selector chart which describes each type, the kind of carrier used in it, the temperature range in which it operates best, and the proper method of application. (Bulletin 103A)

(11) Fume Control

A new publication devoted to the subject of controlling dust and fume produced by electric steel melting furnaces, is now available from Wheelabrator Corp. Entitled "Electric Furnace Fume Control News," it includes a general discussion on the use of local exhaust ventilation and cloth filter collectors for electric furnaces and 13 photographs taken from actual installations, showing the effect. These photos show furnaces, hooding and duct work. In several cases, they compare atmospheric conditions before and after the installation of the fume control system. Some performance data is given, in addition.

(12) Refractories

The Chas. Taylor Sons Co. has published a new bulletin, which describes its "tamul," "tasil" and "tamax" brands of super-refractories. This bulletin discusses the properties and applications of these sillimanite-type or bonded mullite special high temperature refractories. (Bulletin No. 318)

(13) Load Tap Changing

Published by Pennsylvania Transformer Co., is a 16-page booklet on load tap changing equipment. The booklet deals with the company's tap changing mechanism furnished on all their load tap changing transformers up to 7500 kva, on three phase step voltage regulators up to 750 kva, and on all sizes of single circuit unit substations. Over 40 illustrations are used in detailing the construction, operation and application of these load tap changers. Included is a section on control equipment, internal views of transformers, and a brief outline of the methods of paralleling transformers. (Catalog No. 5506)

(14) Boiler Tube Corrosion

"Eleven Ways To Avoid Boiler Tube Corrosion" is the title of a recent publication by the Tubular Products Division of the Babcock & Wilcox Co. This eight-page folder contains important data resulting from an extensive study on the part of the company's metallurgical staff. Many of the causes of corrosion in boiler tubes is explained in detail along with suggested methods of eliminating these same causes. Heating engineers and others who have the responsibility of heating equipment will immediately recognize the value of this bulletin. (TR-537)

(15) Combustion

Thermal Research & Engineering Corp. has published a brochure, outlining its products and services. This bulletin contains detailed diagrams and drawings together with photographs of some of its equipment in use. Engineers dealing with combustion and heat transfer problems will find this informative brochure helpful. It describes some of the possibilities that exist in applying high velocity techniques and shows how problems may be solved with this new combustion technology. (Bulletin No. 108)

(16) V-Belt Drives

A 74-page booklet carrying handy multi-color tables for quick and easy selection of constant speed V-belt drives has been released by Allis-Chalmers Manufacturing Co. In addition to providing selection tables for A, B, C, D and E section belts, the hand book features valuable information on design features, basic drive principles and technical data on sheaves as well as helpful hints for economical, safe and dependable operation of V-belt drives. (Tex-Book 20P40)

(17) Instrumentation

Some 30 instruments are described and illustrated in a new catalog published by Taylor Instrument Companies. Also included are nine schematic drawings showing how instrumentation is applied in the automatic control of metals processing. (Bulletin 98261)

(18) Magnets

The Ohio Electric Manufacturing Co., has published a new four-page bulletin on rectangular separation magnets. The catalog, which gives full details including performance data, etc., on these magnets is profusely illustrated with pictures, and schematic and dimensional diagrams. (Catalog 114)

(19) Receiver Recorder

Available from Bailey Meter Co., is a 12-page catalog describing a receiver recorder that eliminates specially graduated charts, thus making it possible to combine four records on the same uniformly-graduated circular chart. The booklet lists other features and specifications of this new recorder. Numerous illustrations are included. (E12-4)

(20) Clay Guns

A four-page bulletin, published by William M. Bailey Co., describes clay guns for blast furnaces and large electric furnaces. The bulletin describes and illustrates the operation of these clay guns and their construction. (3.5-955)

(21) Equipment Catalog

Salem-Brosius, Inc. has issued a catalog entitled "Equipment For Industry." The brochure is clearly indexed for quick reference, and its 32 pages contain five chapters of descriptive and technical information on how Salem-Brosius products are used. Chapters deal with types of heating and heat treating furnaces, manipulators, clay guns, butterfly valves and single hook grab buckets, materials handling equipment, including heavy duty trailers and custom engineered transfer cars, and the Hyla water purification systems. (SB-14-5-M-9-55)

(22) Silver Anniversary

"Twenty-Five Years of Better Refractories" is the title of a booklet recently published by Mexico Refractories Co. The booklet, issued in celebration of Mexico's silver anniversary, traces the growth of the company and the manufacturing of its products. It contains a listing of distributors, and a complete line of refractory products.

(23) Control System

An eight-page folder published by Leeds and Northrup Co., contains information on an adjusting type control unit and its associated

converter for electro-pneumatic control. This new publication describes how this control system combines the advantages of pneumatic valve operation with the flexibility and fast response of an electrical control system. Included in this folder are photographs and line drawings illustrating the complete control system and all pertinent details of both the control unit and the electro-pneumatic converter. Also included is a description of how the control unit provides proportional automatic reset and rate actions. (Folder ND4 (8)

(24) Magnetic Pulley

Recently issued by Stearns Magnetic, Inc., is a new electro-magnet pulley and pulley separator bulletin incorporating a new simplified pulley selection method. The bulletin includes detailed specifications on the company's magnetic pulleys and pulley separators. Of particular interest is the new simplified selection method which makes it easy for a user to accurately select the right size pulley for his application. Another highlight of the bulletin is the new two-coil pulley design which creates a magnetic field of increased strength and more effective shape, enabling the use of smaller diameter pulleys than was previously possible in many applications. (Bulletin 303C)

(25) Hydraulic Tables Handbook

A new edition of a bulletin entitled "Handbook of Hydraulic Tables and other engineering data" has been made available by the Aldrich Pump Co. It is a comprehensive, 28-page reference work for hydraulic engineers interested in pumping and piping problems.

(26) Sheet Grabs

Mansaver Industries, Inc., has issued a circular illustrating their sheet grabs. The four-page folder describes some of the models designed to handle metals in every form, and lists the feature of these grabs. Dimensions and capacities are also shown.

(27) Pre-Mixed Mortar

Available from the Master Builders Co., is a circular describing their new non-shrink mortar. Seven steps for repairing concrete floors with this new non-shrink mortar is described, and each step is illustrated with an actual photograph and description of the step involved. Also listed are the advantages of using this pre-mixed mortar and its compressive strength.

(28) Proportional Control

Offered by the Foxboro Co. is a bulletin describing the company's complete line of electric proportional controllers. The bulletin explains the functions of three types of electric control: proportional plus manual reset; proportional plus automatic reset; and proportional-set average-position. Explained, too, are the design features that eliminate slidewire friction so that accurate measurement and precise control action are assured. Separate sections are devoted to the electric-operated control unit, the electronic relay and the valve operator. Among the illustrations are typical installation views and an actual chart record showing temperature control of an electrically heated furnace. (Bulletin 4-11)

(29) Battery Maintenance and Service Manual

A 48-page manual on lead acid batteries for all types of motive power application has just been issued by C & D Batteries, Inc. The manual covers industrial cycle service in its entirety. The book includes photographs, charts, tables, methods of repairs, maintenance and salient points on theory of operation, instructions covering repairs with regular or special tools, simplified testing methods including safety practices acid handling precautions, and instruction on correct charging methods. The new manual is cross-indexed for easy reference and includes a suggested list of spare parts required to make immediate repairs with a minimum of production shutdown time.

(30) Aluminum Bus Bars

The use of aluminum bus bars in both feeder and plug-in or trolley busway distribution systems is described in a new two-color, eight-page bulletin issued today by the Distribution Assemblies Department of the General Electric Co. The publication lists the advantages resulting from the use of aluminum as a conductor in busway applications. It explains in detail construction features, operating characteristics, and specifications. (GEA-6169)

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1011 EMPIRE BUILDING
PITTSBURGH 22, PA

IRON & STEEL ENGINEER
Send The *free* Booklets Circled Below:

*NOVEMBER, 1955

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	50	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89
90	91												

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

*INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER MARCH 1, 1956

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MFG. CO.	BULLETIN A	Insulating bushings.
51	AMERICAN FLEXIBLE COUPLING CO.	CATALOG 501 AND BULLETIN 1052	Fully crowned tooth form couplings.
52	BAILEY METER CO.	SPEC. E12-5	Receiver recorders.
53	BRISTOL CO.	BULLETIN P1248	Electronic pyrometer controllers.
54	CHANDEYSSON ELECTRIC CO.		Electrolytic generator.
55	DE LAVAL STEAM TURBINE CO.	BULLETIN 0504	Centrifugal blowers and pumps.
56	DIAMOND POWER SPECIALTY CORP.		Industrial wired television.
57	DRAVO CORP.	BULLETIN 225	Unloaders, trolleys, and other equipment.
58	DRAVO CORP.		Lubrication and coolant systems.
59	ELECTRIC MACHINERY MFG. CO.	FOTO-FACTS NO. 16	Modern motor applications.
60	EUCLID ELECTRIC & MFG. CO.	BULLETINS 4400 AND 4401	Combination manual and magnetic controllers.
61	EXIDE INDUSTRIAL DIVISION, ELECTRIC STORAGE BATTERY CO.	FORM 1982	Motive power batteries.
62	FALK CORP.	BULLETIN 3104	All-steel motoreducers.
63	FARREL-BIRMINGHAM CO., INC.		Roll grinding.
64	FLOWER MFG. CO., D. B.	CATALOG 4-1	Brush holders.
65	GENERAL ELECTRIC CO.	BULLETIN GEA-2244	Engineering services.
66	HOMESTEAD VALVE MFG. CO.		Hypressure steam cleaner.
67	HUNT & SON, INC., C. B.	BULLETIN NO. 531	Hydraulic valves.
68	JOHNS-MANVILLE CORP.	IN-115A	Insulating brick and insulating fire brick.
69	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Detailed descriptions, drawings, etc., on couplings.
70	KOPPERS CO., INC., FREYN DEPT.		Pneumatic bell hoist.
71	LEEDS AND NORTHRUP.	ND46(1)	Complete line of null-balance potentiometers.
72	LINK-BELT CO.	BOOK 2416	Belt conveyor idlers.
73	LUBRIPLATE DIVISION, FISKE BROTHERS REFINING CO.		Lubrication.
74	MINNEAPOLIS-HONEYWELL REGULATOR CO.	DATA SHEET NO. 6.4-8b	Molten steel temperature measurements.
75	MURRAY MFG. CO., D. J.	CATALOG BC-1049	Grid blast coils.
76	OHIO ELECTRIC MFG. CO.	BULLETIN 112	Magnets and magnet controllers.
77	OHIO KNIFE CO.		Slitting.
78	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG NO. 9-A	Various types of melting and refining furnaces.
79	PRATT & WHITNEY CO., INC.		Gages and automatic controls.
80	RADIO CORP. OF AMERICA.		Industrial television.
81	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN A-1555	Drive sytems
82	RUST-OLEUM CORP.		Rust preventive literature and color chart.
83	SELAS CORP. OF AMERICA.		Heat processing methods.
84	SPRAYING SYSTEMS CO.	DATA SHEET 6120	Descaling nozzles.
85	SUTTON ENGINEERING CO.	BULLETIN NO. 25	Straighteners.
86	TAYLOR INSTRUMENT CO.	BULLETIN 98261	Drawings and information on individual instruments.
87	UNITED STATES GRAPHITE CO.		Brush catalog.
88	WAGNER ELECTRIC CORP.	BULLETIN IU-36	Hydraulic crane brakes.
89	WHEELABRATOR CORP.	BULLETIN 864	Blast descaling principles.
90	WILSON-SNYDER WORKS, U. S. STEEL CORP.		Specifications on pumps.
91	YODER CO.		Cold roll forming.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1011 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The free Booklets Circled Below:

*NOVEMBER, 1955

1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	50	51	52	53	54	55	56	57	58	59	60	61
62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89
90	91												

NAME _____ TITLE _____

DEPARTMENT _____

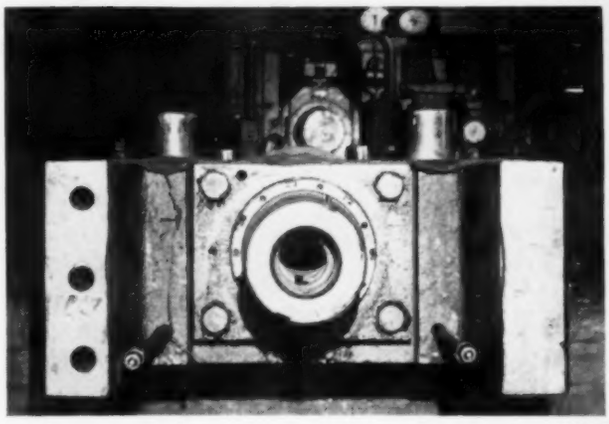
COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

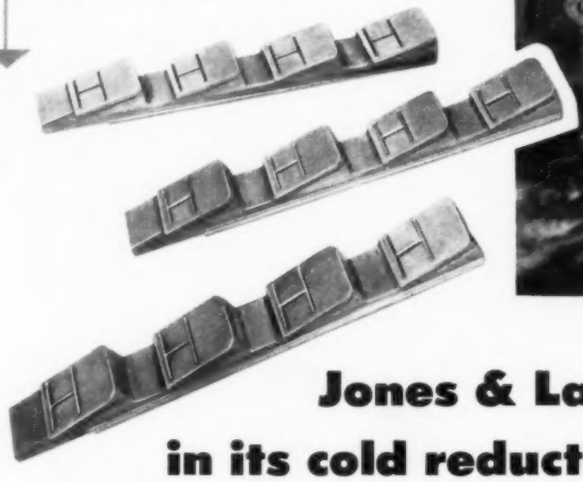
*INQUIRIES FOR ITEMS LISTED IN THIS ISSUE NOT VALID AFTER MARCH 1, 1956

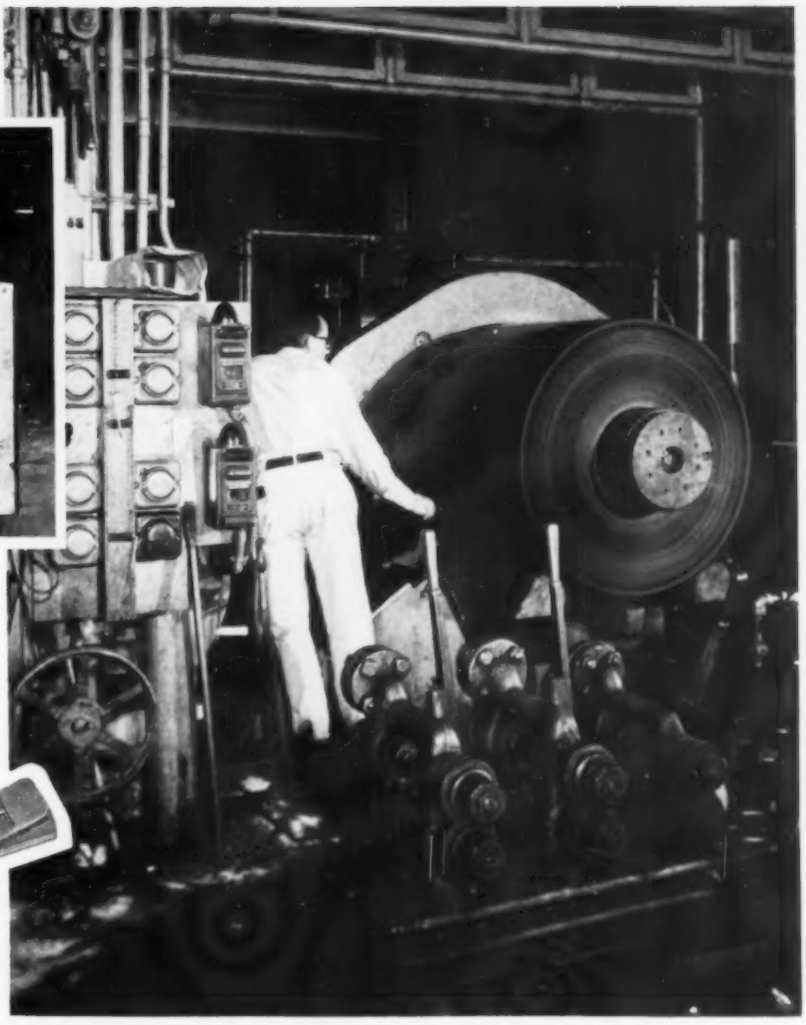
Tension reel operation. Ampco Metal wedges and hydraulic plungers have a major role in maintaining high production standards and lowering costs here.



Work roll and back-up roll go into place. Four Ampco hydraulic plungers are used.

Ampco Metal wedges used in tension reels at cold reduction mills. They're tough, wear longer and mate with steel parts.





Jones & Laughlin uses AMPCO* METAL in its cold reduction mill at Aliquippa

. . . to reduce costs and maintain high production.

AMPCO Metal wedges are used in tension reels at this cold reduction mill. Rugged duty? It sure is. Crushing pressures and tremendous weights are constantly applied. Every three to five minutes, depending upon the gauge of material going through, the reel collapses to enable the coil to be removed. That's why Ampco Metal is used. It's tough, wears longer and has the ability to mate with steel parts.

You'll find Ampco Metal hydraulic plungers used in this cold reduction mill, too, and for the same reasons. In many cases, there are two small hydraulic plungers on the work roll, and two heavy Ampco plungers on the back-up rolls. When the operator feeds in a new coil, a set of Ampco hydraulic plungers work against the back-up roll and another set works against the top work roll.

For years, steelmen have specified Ampco Metal for the toughest and most demanding requirements because it keeps mills running, reduces costs, and maintains high production standards. For example, you'll also find Ampco Metal slippers; screw-down nuts and many other Ampco applications in steel mill operations.

Keep your mill humming — use Ampco Metal in the tough spots to resist wear. Write today for complete information or contact your nearby Ampco field engineer.

AMPCO®
Sole producer of genuine Ampco Metal

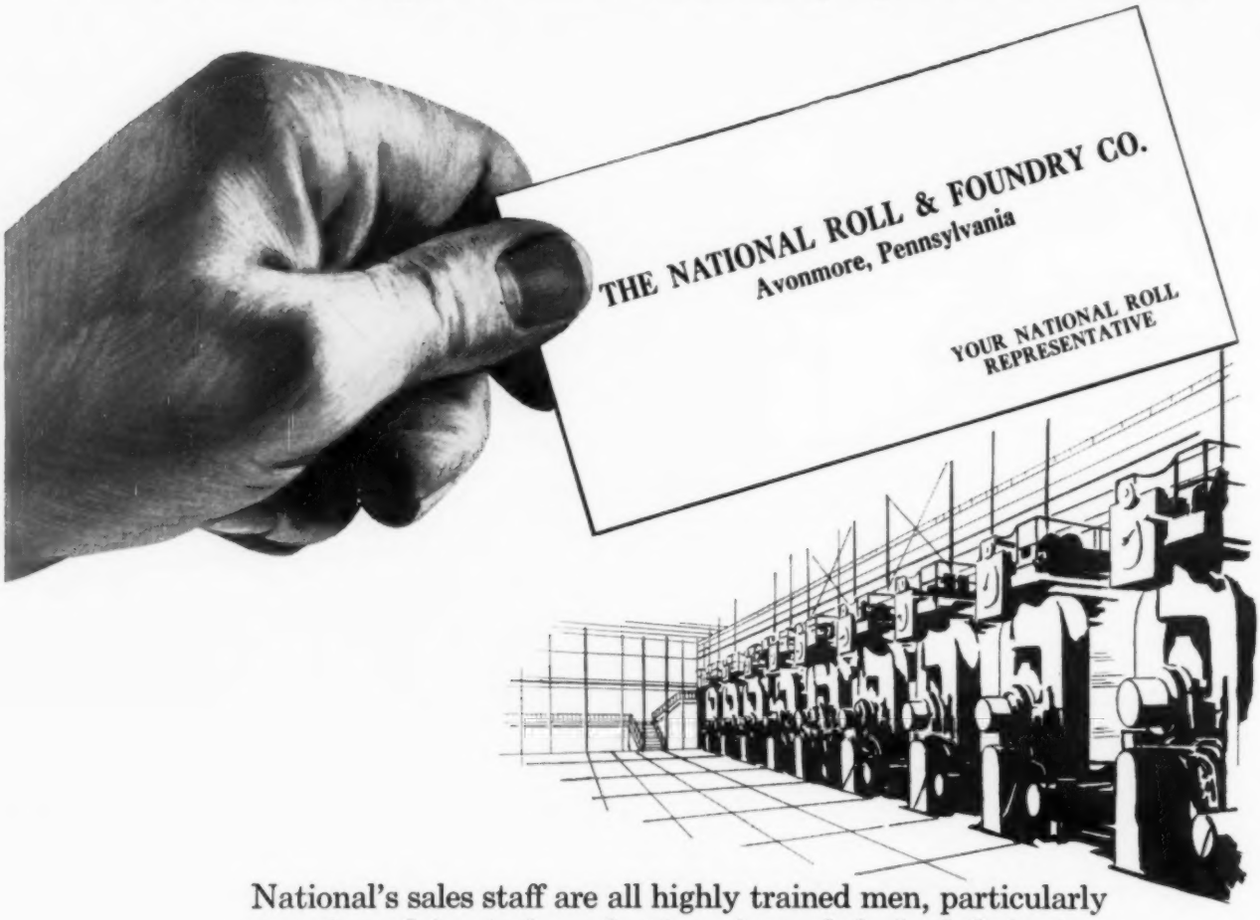
AMPCO METAL, INC.
Dept. IS-11
Milwaukee 46, Wisconsin
West Coast Plant
Burbank, California

*Reg. U. S. Pat. Off.

C-31

Roll Problems?

Here's a good man to help you lick them



National's sales staff are all highly trained men, particularly experienced in steel production. A good deal of their time is spent in customers' plants analyzing production problems and advising the type of rolls and castings that will do each particular job most satisfactorily.

They are well aware of the many metallurgical and rolling problems that occur and are ready to help you find the solution.

. . . So the next time you run into a production problem, be sure to call on your National Roll representative—he is ready to serve you.

THE NATIONAL ROLL & FOUNDRY CO.

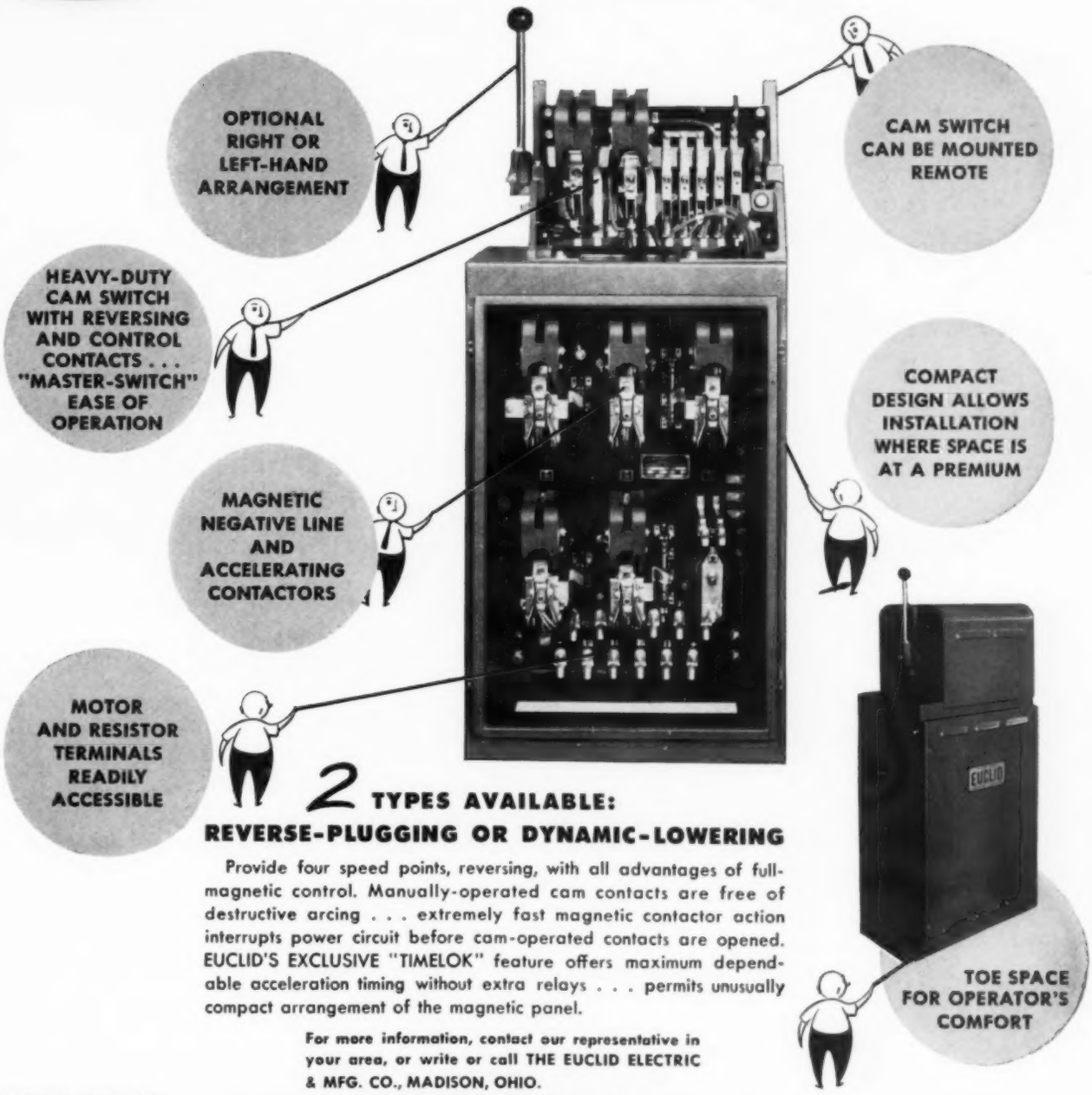
Avonmore, Pennsylvania

Specialists in Iron, Alloy Iron and Steel Rolls and Castings, Steel Armor Castings

NEW

HEAVY-DUTY D-C MAN-NETIC CONTROLLERS*

Combination Manual and Magnetic Controller for Cranes . . . Charging Machines . . . D-C Control Jobs


OPTIONAL RIGHT OR LEFT-HAND ARRANGEMENT
CAM SWITCH CAN BE MOUNTED REMOTE
HEAVY-DUTY CAM SWITCH WITH REVERSING AND CONTROL CONTACTS . . . "MASTER-SWITCH" EASE OF OPERATION
COMPACT DESIGN ALLOWS INSTALLATION WHERE SPACE IS AT A PREMIUM
MAGNETIC NEGATIVE LINE AND ACCELERATING CONTACTORS
MOTOR AND RESISTOR TERMINALS READILY ACCESSIBLE
EUCLID
TOE SPACE FOR OPERATOR'S COMFORT

2 TYPES AVAILABLE:

REVERSE-PLUGGING OR DYNAMIC-LOWERING

Provide four speed points, reversing, with all advantages of full-magnetic control. Manually-operated cam contacts are free of destructive arcing . . . extremely fast magnetic contactor action interrupts power circuit before cam-operated contacts are opened. EUCLID'S EXCLUSIVE "TIMELOK" feature offers maximum dependable acceleration timing without extra relays . . . permits unusually compact arrangement of the magnetic panel.

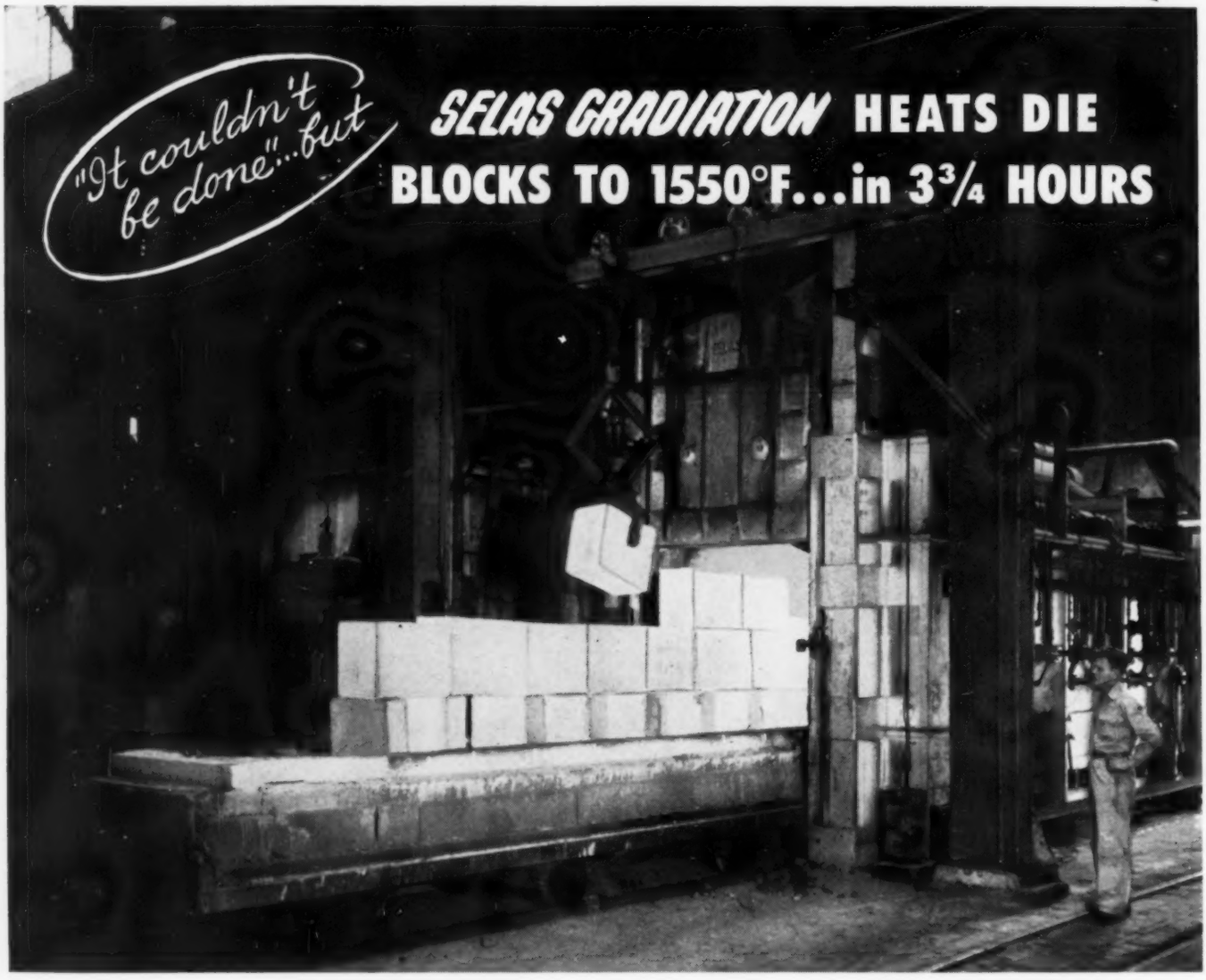
For more information, contact our representative in your area, or write or call THE EUCLID ELECTRIC & MFG. CO., MADISON, OHIO.

*PATENT APPLIED FOR

Ask for Bulletin 4400-4401.

THE EUCLID ELECTRIC & MFG. CO.
MADISON, OHIO

THE EUCLID ELECTRIC
EUCLID
AND MFG. CO., MADISON, OHIO



New Selas automatic heat processing method increases production rate 4½ times . . . decreases fuel consumption 20% . . . improves plant efficiency

Reduction of a conventional 20 to 30 hour heating cycle to less than four hours . . . with a corresponding increase in production rate . . . has been achieved through use of a Selas Gradiation furnace at the Heppenstall Company, Pittsburgh, where alloy steel die blocks, 8" to 24" thick, are heated to 1550°F. for hardening.

The completely automatic program-control heating method achieves reproducible uniformity in die block quality and assures that fast heating of large steel sections is practical and safe.

- The precision timing of the heating cycle permits close scheduling of quenching facilities and manpower, resulting in higher overall plant efficiency.
- Less labor (only about 20 minutes per heat) and less highly skilled operators are needed . . . to produce uniform results within each heat, and from heat to heat.
- Fuel consumption, per pound of steel heated, is reduced 20%.

The Selas gas-fired furnace, factory prefabricated, was in operation one week after delivery, eliminating six weeks of interruptions to plant operations customary with plant-site erection of other furnaces.

The benefits of Selas Gradiation heating apply to small as well as large metal sections and include heat treating, brazing, forging, strip heating and many other continuous operations.

Write for descriptive data on Selas heat processing methods. Informative article describing the Heppenstall die block heating installation also available.

SELAS

SELAS CORPORATION OF AMERICA
PHILADELPHIA 34, PENNA.

Pile-ups cost plenty!

...So they prevent them at Gary with RCA Industrial TV

One pile-up at United States Steel Corporation's Gary Sheet and Tin Mill could mean as much as 15 minutes lost production time, or approximately 120 tons of steel! So, at their 80-inch strip mill they installed RCA Industrial TV. This mill holds the world's record for production of hot strip.

A TV screen on the control pulpit (see photo) permits the operator to maintain control of the movement of the hot strip. Television affords the opportunity to keep constant watch and to spot threats of pile-ups before damage occurs. In this way control of strip shape is improved, costly delays are minimized . . . hundreds of tons of steel are saved. The RCA Industrial TV system has been in continuous operation for over a year.

Have you problems of observing operations where it's too hot . . . too dangerous . . . too inaccessible for men to go? RCA Industrial TV permits continuous close supervision of rolling mill operations, furnace combustion, tapping, pouring, and similar hazardous procedures. And RCA's practical Service Plan provides for service by experienced factory-trained RCA engineers. Let us make a survey of your Industrial TV requirements without obligation. Use coupon below for literature.

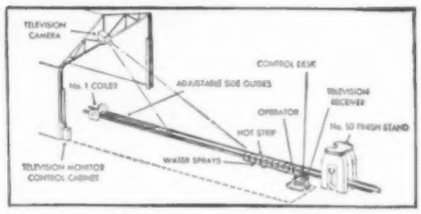


Diagram showing TV camera mounting

RCA CAMERA . . . compact, rugged, built to give unfailing service under rough operating conditions. Uses the sensitive RCA-developed time-proven Vidicon Tube.

RCA MONITOR . . . shows stable, high-definition picture, assures accurate reproduction of fine details. For convenience and ease of operation all controls for camera and TV are located on control monitor.

ACCESSORIES . . . include water-cooled camera lens, explosion-proof housing, panel-mounting monitor, camera switcher, industrialized auxiliary viewer, remote iris, remote focus, pan and tilt assembly, and other field-proven equipment.

New low prices now in effect

RCA

RADIO CORPORATION of AMERICA

CAMDEN, NEW JERSEY

In Canada: RCA VICTOR Company Limited, Montreal

Radio Corporation of America
Dept. Y-188, Building 15-1, Camden, N. J.

Please send me new booklet, "Supervision by Television."

NAME _____ TITLE _____

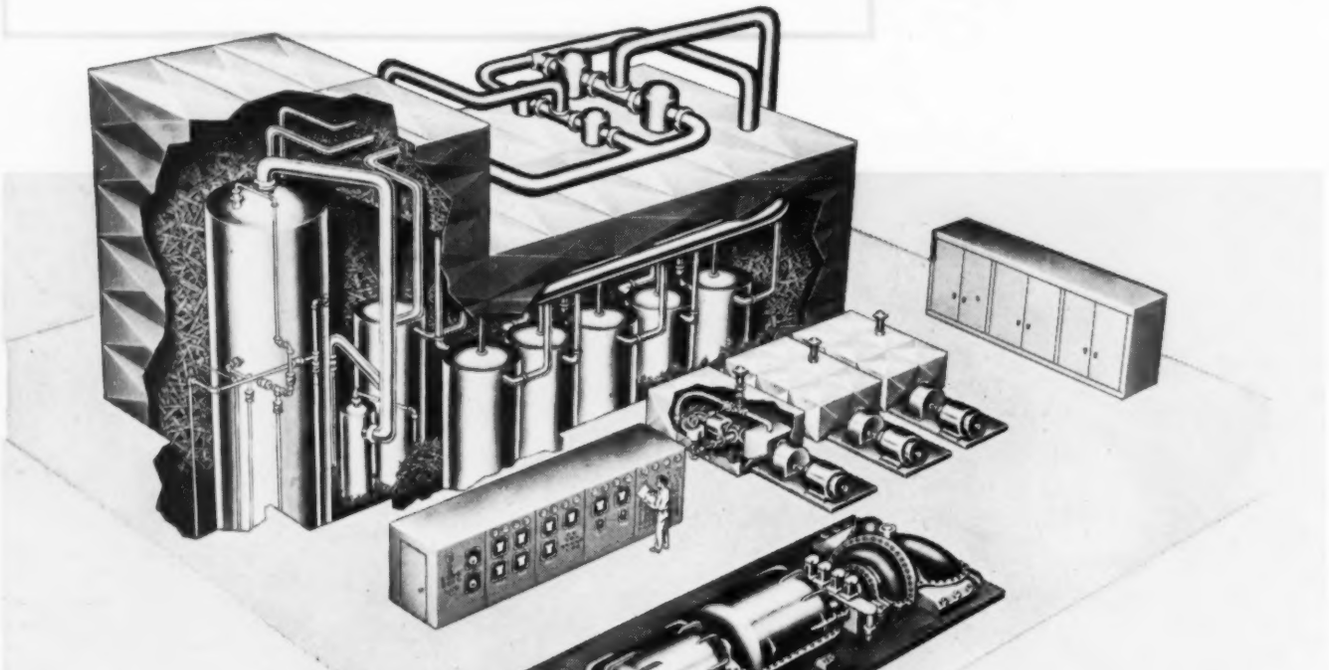
COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Let Air Products Engineers

discuss your expansion plans—
OXYGEN can mean more steel



More than 100 Air Products engineers are at your service.

What plant additions are you planning, to produce your share of the 24,000,000 ton steel ingot increase by 1960?

Even though your planning may be in the preliminary stage, a conference now with our engineers may help you to better evaluate your expansion program. Let us give you actual costs and engineering information from data based on tonnage—180 tons per day to 500 tons per day—oxygen generators we have actually placed in operation.

You can have oxygen and nitrogen generators to fulfill your requirements, on a lease basis, without capital investment—whether your requirements are for:

Large Capacity Tonnage Generators, regardless of size, purity, high or low pressure cycle, with liquid oxygen pumps, if your oxygen should be under pressure

or

"Packaged" High Purity Generators, producing high purity oxygen and nitrogen simultaneously—oxygen delivered safely under pressure by Air Products patented liquid oxygen pumps.

Let our engineers review your requirements and give you actual figures for oxygen generating equipment in your expansion plans—even though your plans are only preliminary now.

LOW COST OXYGEN...NITROGEN

Air Products
INCORPORATED
Dept. P, Box 538, Allentown, Pa.

Equipment News...

TRACKMOBILE

▲ A new heavy-duty Trackmobile that hauls, switches and spots railroad cars has been manufactured by the Whiting Corp. It is designed for use on factory sidings, mines and quarries, and other industrial trackage.

The heavy-duty Trackmobile operates on both road and track. It travels on roadways, or across track, or four pneumatic wheels. When astride a track, the automotive-type road wheels are retracted and the machine rests on its steel rail wheels, ready for track operation. This conversion from road to rail wheels takes only 90 seconds. The Trackmobile is then ready to travel on the tracks, couple to freight cars, and push or pull them. The machine can be driven over unimproved tracks — special crossing points are not required.

The Trackmobile develops a draw-bar pull much greater than its own weight. After the machine has been coupled to a car, a constant-pressure type hydraulic jack lifts the freight car slightly and thus transfers part of the car's weight onto the Trackmobile. This enables the machine to develop as much as 12,800 lb of draw-bar pull, which is sufficient to pull a number of heavily loaded cars.

The operator does not have to get out of his cab to couple or uncouple. All controls, including those for positioning, raising and lowering the automotive-type wheels, and coupling and uncoupling, are located in the cab. The cab is elevated and enclosed in glass to provide 360 degrees visibility and all-weather operation.

The Trackmobile has electric sanders built into the frame, for operation on wet or icy track. It has two head lights and a tail stop light for road use, and two combination running and rear lights for track use. Another feature is the ability of the unit to double as a tractor for pulling carts and skids about the plant on its pneumatic road wheels.

When Trackmobile is astride rails (left), operator pushes hydraulic control lever and lowers track wheels. At right, unit pulls several cars loaded with coal.

FILTER

▲ A small, cleanable, all metal, edge-type filter has been designed by the Cuno Engineering Corp. to remove micronic particles from large quantities of liquid. The new filter, Super Auto-Klean, stops all particles larger than 40 microns (other degrees of filtration are 75 microns and .005 in.). In those cases where finer replaceable cartridge type elements are used as secondary filters, cartridge life is greatly extended because the filter prevents premature plugging of filtering surfaces in the secondary cartridge by removing all oversized particles and agglomerated contaminants.

Because of the unusually low pressure drop, flows can be handled in a space six times smaller than would a cartridge type unit under similar conditions. For example, a single 40 micron filter measuring only 15 in. high by 6 in. diameter will handle 30 gpm of 200 SSU oil with only a 3 psi pressure drop. With a slightly higher pressure drop 75 per cent more flow can be handled. A replaceable cartridge type filter for the same service would measure approximately 30 in. high by 10 in. diameter and pressure drop would vary from 3 to 30 psi.

TESTING!

This universal testing machine, capable of applying loads up to 5,000,000 lb., was dedicated in the new Fritz Engineering Laboratory at Lehigh University October 14, by Dr. Eugene G. Grace, chairman of Bethlehem Steel Co. and president of the Lehigh University board of trustees. Weight of the machine and accessories is approximately 925,000 lb. Height is approximately 60 ft above test floor and 16 ft below, a total of 76 ft. Clear space between columns is 10 ft wide. Specimens or structures up to 40 ft high can be tested in tension above the sensitive crosshead or in compression below the sensitive crosshead. Base structure will accommodate structures up to 100 ft long, 40 ft high, and nearly 10 ft wide for test loads.

These design features of small size, high flow rates and low pressure drop are combined with cleanability. Cleaning is done without stopping flow, simply by turning the handle, by hand or motor drive. Accumulated sludge may be drained off at convenient periods through the bottom drain plug.

TESTING UNIT

▲ Bailey Meter Co. has purchased a Cities Service Co. Heat Prover combustion analyzer for oxygen and combustibles in flue gases. The Heat Prover will become part of the Bailey

HOW
STATIONARY
WHEELS
CAN REDUCE YOUR
PIG CASTING COSTS

Bailey
PIG CASTING
MACHINES

Ideal for use in foundries and small metal producing plants, these machines provide exceptional economy and durability due to a unique design feature. The endless chain carrying the mounds runs over a series of "stationary wheels" mounted on the frame. This eliminates 80% of the moving parts. Results are increased capacity and a substantial reduction in maintenance and operating costs. Furnaces can be tapped direct into the machine—eliminating the furnace-to-ladle operation. Capacities: 3 to 50 tons per hour. Lengths: 15 to 125 feet, in multiples of 5 feet.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

line of instruments and control equipment for the economical use of fuels.

It will be manufactured and sold by Bailey Meter as a portable testing device for the burning of solid, liquid, and gaseous fuels. The Bailey distribution policy will differ from that of Cities Service in that Bailey will sell rather than loan these combustion analyzers to those interested in testing and adjusting fuel burning equipment for maximum combustion economy.

Portable combustion analyzer employs the same principle of catalytic combustion as the Bailey Oxygen and Combustibles Recorder.

Cities Service retains the right to continue analyzer loan service to users of its petroleum products.

The Bailey Heat Prover combustion analyzer is identical to the former Cities Service analyzer. It is a portable instrument weighing about 25 lb, designed to conduct an analysis of a gas sample for oxygen and combustibles gas content. The per cents by volume of these gases in the sample are continuously and simultaneously indicated on the instrument meters. The complete package includes a sampling pump, hose and tip, as well as a thermocouple for measuring temperature. It operates on a 110 v, 25-60 cycle a-c power source. The oxygen and combustibles meters have both 4 per cent and 20 per cent range spans. This dual range feature affords greater instrument accuracy and sensitivity. The oxygen indicator is provided with an additional scale for measuring the output of the instrument thermocouple in degrees Fahrenheit.

The combustion analyzer has found widespread application in the furnace operations of the steel industry, on glass tanks, cement and lime kilns, ceramic and refractory kilns, steam boilers, and also on direct and indirect-fired furnaces in the metals and metals processing industries.

TURBO-BLOWER

in "perfect condition" after 40 months' service

AAF Multi-Duty—today's most widely used self-cleaning filter for supplying clean air for blast furnace operation and motor room ventilation.

MULTI-DUTY air filter collects 3600 wheelbarrow loads of dirt in protecting vital equipment

THE date—April 12, 1955. The place— a southern mill of one of the nation's major steel companies. The occasion—inspection by plant officials of turbo-blower serving blast furnace to determine condition of rotor after 40 months of uninterrupted service. The findings—rotor in "perfect condition" with no blade erosion, oil entrainment or visible dirt in evidence.

Reason for this outstanding service record—intake air for turbo-blower was cleaned by a 60,000 cfm AAF Multi-Duty Air Filter. It was a "king size" cleaning job, too—with an estimated wheelbarrow of dirt being collected every 8 hours or a total of 3600 loads over the 40 month period.

Constant efficiency and uniform air cleaning are assured, regardless of dust load, with the self-cleaning Multi-Duty. This air filter keeps itself "shipshape" automatically; works every shift every day; requires no attention other than periodic inspection and removal of sludge.

How can you verify these facts? Just ask your local AAF representative for a list of long-time, satisfied Multi-Duty users. It reads like the "Who's Who" of the steel industry.

AAF
herman nelson

American Air Filter
COMPANY, INC.

American Air Filter of Canada, Ltd., Montreal, P. Q. • 302 Central Avenue, Louisville 8, Kentucky

Designed and Built
for Greater Strength...
and Durability...

BESSEMER CONVERTERS

AND AUXILIARY EQUIPMENT

Backed by more than three-quarters of a century of engineering know-how, fabricating and erecting experience—Bessemer Converters by Pennsylvania Engineering are the standard of quality and rugged durability throughout the iron and steel industry. Completely assembled, aligned and mechanically operated in our shops before shipment, they feature increased efficiency in the tilting mechanism, precision cut gearing and antifriction bearings.

PENNSYLVANIA ENGINEERING CORP.

NEW CASTLE, PA.

For over 75 Years DESIGNERS, FABRICATORS AND ERECTORS OF STEEL MILL EQUIPMENT

OTHER STEEL PLANT EQUIPMENT WE BUILD

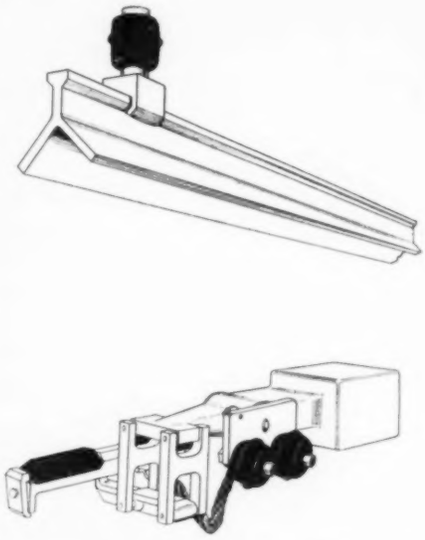
Blast Furnaces . . . Open Hearth Furnaces . . . Hot Metal Mixers . . . Hot Metal Mixer Cars . . . Ladles . . . Ladle Transfer Cars . . . Scrap Cars . . . Slag Cars . . . Thermo Metal Cars . . . Jack Cars . . . Ingot Cars

Photo courtesy James J. Laughlin, Aliquippa Works

CONDUCTORS

▲ Now being offered for general application for the first time by the Cleveland Crane & Engineering Co., are aluminum "Inverted-Y" conductors with especially engineered sliding shoe collectors to handle heavy current requirements of overhead traveling cranes.

The conductors are heavy aluminum extrusions, available in 300, 500, 1000 ampere and larger sizes. They may be either side-or overhead-mounted to crane girders or runways by hangers especially made to permit the conductors to float. This obviates the need of expansion joints and eliminates strain on the insulators, thereby minimizing their breakage.



Hangers are made to permit the conductors to float (top), thereby eliminating need of expansion joints and preventing strain on insulators. Counterweight-type collector (bottom) maintains constant pressure of sliding shoes on side-mounted conductor bar.

The current collectors are extra heavily built to give long trouble-free service on hard-duty applications. They are provided with a counterweight which maintains constant pressure of the sliding shoes on the conductor bar. Each collector has two shoes which assure uninterrupted current flow. The shoes are in tandem and can be easily replaced by loosening one stud bolt for each. Because of pantograph motion and a ball and socket connection at the shoe support, positive contact will be maintained even if a bar becomes misaligned in either the horizontal or vertical plane.

STOOLS

• weighing 10,000 pounds each
• alloyed 25% Cr—12% Ni
• for 1750°F. temperatures

DURALOY

These stools should offer a very pertinent tie-in with your casting requirements. Essentially, they are alloyed to resist heat. They're typical of the heavy high alloy castings we are equipped to turn out.

They will serve also to indicate what we can do in the way of producing castings to resist not only high temperatures but severe corrosion or combinations of heat and corrosion, as well.

Today, we can offer several distinctly different types of castings in the high alloy field including static, centrifugal and shell-molded.

Many in both the metal working and processing fields have come to look upon Duraloy as the leading producer of exclusively high alloy castings. This reputation has been built on many years production of sound castings properly alloyed. We'll be glad to discuss your high alloy casting requirements.

THE DURALOY COMPANY
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

Although Inverted-Y electrification has been used on Cleveland cranes since 1948, this is the first time it has been offered for application on all makes of cranes and runways. The conductors, collectors and necessary fittings will be furnished for installation by the purchaser.

Advantages include: high capacity, low voltage drop, low reactance, light weight, rigid section, corrosion resistant, floating hangers, non-arcing collector shoes, two mounting styles, easy erection and available parts.

HAND STAMPER

▲ A new development in steel hand-stamping has been introduced by Jas. H. Matthews & Co.

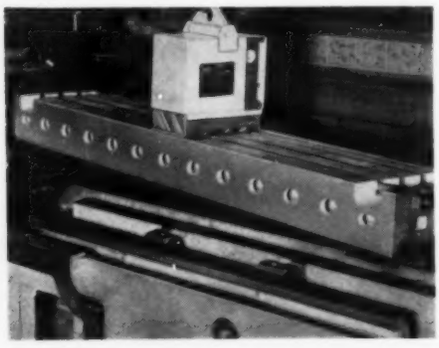
Designated as "Sur-grip," the unit is produced by the addition of specially engineered, precise serrations running horizontally across the two sides of the stamps held between the thumb and fingers during the marking operation. This feature correctly positions the fingers at their best points for stress-free, secure holding. Controlled, even-depth marking is made easier, because of the added feeling of security to the user that the stamp cannot slip or fly out of his hand during the marking impact. These stamps, made from properly selected tool steels, also include a device which prevents mushrooming of the stamp head due to hammer blows.

Another new feature of these stamps is in their packaging. A sturdy plastic bench box, practically damage-proof, has been designed so that the letters and figures are positioned in the holding grid for instant selection and use. A large, legible letter or figure corresponding to the character engraved on the stamp face is in full view on the exposed upper portion of each stamp for positive identification.

MAGNET

▲ The Ohio Electric Manufacturing Co. has announced a new 4000-lb-capacity, battery-operated lifting magnet.

Designated as the model SL-4 Ohio Shop-Lifter, the new unit is specially designed to be used indoors in manufacturing plants. Because the unit is powered by self-contained, 12-volt automotive batteries, there is no chance of sudden power failure such as can occur with lifting magnets powered from mains. This feature, plus the fact that the length of haul of the unit is not restricted by electrical wires, makes the Shop-Lifter ideal for use on lift trucks, shop hoists, conveyor lines, etc.



The large 7 3/16 × 20 in. magnetizing surface provides deep magnetic penetration for odd-shaped parts which might be difficult or impossible to lift with sling, hook or grapple.

The magnet is virtually maintenance-free. Batteries need be recharged only every five to 12 average workshifts, or as shown by the battery-charge indicator on the control panel. The panel also incorporates a receptacle for connecting a trickle charger furnished as optional extra equipment.

Call Lawrence...
FOR FAST, DEPENDABLE SERVICE
Pure Copper Tuyeres and Cooling Plates
BRASS & BRONZE CASTINGS

IN THE HEART OF THE PITTSBURGH DISTRICT

Lawrence Copper and Bronze offers district steel plants a fast, dependable source of supply for high quality, trouble-free pure copper castings.

Since 1888, Lawrence has continuously served many of America's large steel plants. The wide experience gained in specializing in these few, but very important, products is at your disposal. We're as close as your phone and will be pleased to be of assistance on any problems that arise at any time.

Pure Copper Castings
Tuyeres • Tuyere Coolers • Bosh Plates
Mantle Plates • Cinder Notches
Valve Gates and Seats
Heavy Brass and Bronze Castings
Bearings • Machinery Bronze
Bars • Bushings

LAWRENCE COPPER & BRONZE CO.
ZELIENOPLE, PA.
BOX 246 PITTSBURGH DIST. PHONE 774

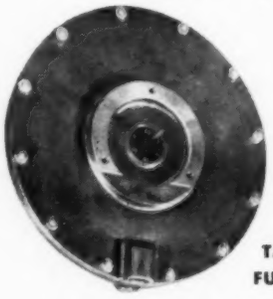
SEND FOR THIS NEW CATALOG

to see how Taylor instrumentation can help you cut costs!

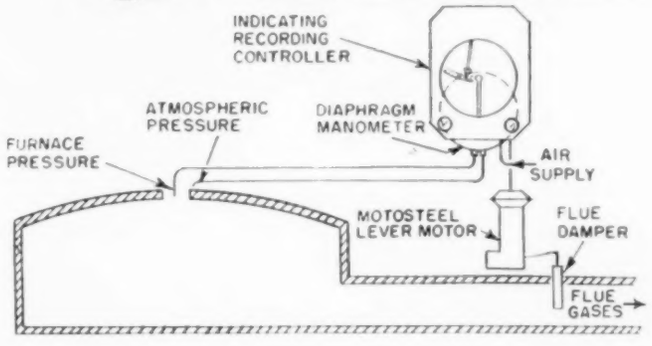
Automatic control in the metals industry is becoming more and more of a factor in many aspects of production and processing. And when it comes to accurate, rugged and dependable instrumentation Taylor Instrument Companies has an enviable reputation throughout the industry. This new catalog contains valuable information about individual instruments, together with many schematic drawings showing actual applications.

EXAMPLE: Do you have a problem in the measurement of low pressures, differential pressures or rates of flow in air or gas lines?
This new Taylor System, employing the diaphragm type manometer for the measuring element, is particularly suitable for accurate low pressure measurement of air or gas, static or differential, with operating ranges as low as minus 0.5 to +0.5 inches or up to 0 to 4 inches of water. It has been designed for close fitting on the back of the Taylor line of indicating, recording and controlling instruments, and the simplified zero adjustment is easily accessible inside the instrument case.

Ask for **Bulletin 98261,** or call your Taylor Field Engineer.
Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



TAYLOR DIAPHRAGM MANOMETER FOR FURNACE PRESSURE OR DRAFT CONTROL



Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

Looking for millionths of an inch to keep your Crane Valves tighter longer

How big is a micro-inch?

At Crane it's *mighty big* . . . because it is one of the noticeable differences between Crane Quality Valves and the run-of-the-bin kind.

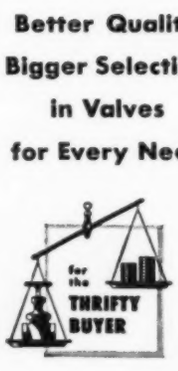
Measuring seating surface smoothness in micro-inches is the job of the Crane technician in the picture. His findings are important to keeping Crane production at the high-quality level.

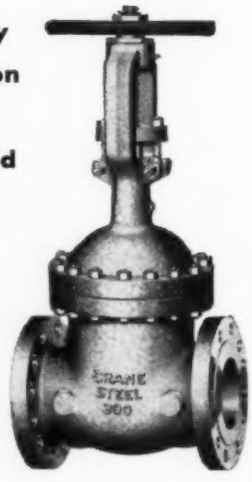
Crane carefully measures seating surface smoothness to make sure that the Crane Valves you install will operate smoothly without seizure, seat tightly and wear longer, thus helping reduce your maintenance and repair costs to the minimum.

Such care in manufacture for more than 100 years is just *one* reason why thrifty buyers prefer Crane Valves . . . why industry keeps on using more Crane Valves than any other make . . . why you should always buy Crane.

Crane Co., General offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

Better Quality
Bigger Selection
in Valves
for Every Need





CRANE CO.

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

VALVE ACTUATOR

▲ A self-contained electro-hydraulic valve actuator which vastly increases the advantages and utility of electronic control systems has been developed by the Askania Regulator Co.

The electro-hydraulic valve actuator is a complete self-contained unit including control valve, hydraulic power source, and proportional positioning mechanism which can be used

with existing electronic controllers. Outside connections consist of the signal wires from the controller and an electric power supply. The signal current is applied to a high-resistance coil (3000 ohms or more) which moves in a magnetic field. Linked to the coil is Askania's exclusive Jet Pipe which converts an electrical signal of less than 50 milliwatts into the powerful stroke of a control valve.

The valve moves at a speed of better than one in. per second. Thrusts of 600 lb and more can be handled, with strokes presently available up to two in.

STRADDLE CARRIER

▲ Syncromesh transmission, full hydraulic control of load hooks and radi-arc steering are features of a new model straddle carrier introduced by

HERE'S THE USG® BRUSH THAT DOES AN OUTSTANDING JOB ON ALL YOUR MILL MOTORS

When you replace the brushes on your mill motors, you can get the best results with U S G Grade 135 Brush with Statite®. For brushes that give superb results in other applications, see below. Write for your copy of the complete U S G Brush catalog today.

A typical U S G Grade 135 Mill Motor Brush with Statite*

U S G Grade 223 Brush for DC crane motors with Statite*

U S G Grade AH897 Brush for Welding generators with Statite*

U S G Grade 1658 Brush for tin line collector rolls

U S G Grade 550 for AC Crane Motor Rings

*Permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

203

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

this man is SAVING his company money...

SPEEDING PRODUCTION

He's stripping oily grime from machine tools with Hypressure Jenny *before repairs or repainting.* He's *saving his company* money, because he is doing the job in one-sixth of the time taken by hand methods. Also it is a known fact that when mechanics work on clean equipment, unhampered by grease and grime, production steps up . . . job time is shortened . . . costs are reduced.

But that's only half of it!

Besides cleaning all types of production machinery, tools and equipment, Jenny saves up to 90% of the time and labor costs of cleaning floors, walls, windows, and lavatories . . . reduces fire hazard; increases plant safety; and speeds production through better working conditions.

If you would like to know more about HYPRESSURE JENNY STEAM CLEANER and the many ways it can save your company money . . .

WRITE, OR MAIL THE COUPON TODAY! No Obligation.

HYPRESSURE Jenny STEAM CLEANER

Without obligation send me complete information on HYPRESSURE JENNY STEAM CLEANER

Name_____ Title_____

Company_____

Address_____

City_____ State_____

HYPRESSURE JENNY DIVISION
HOMESTEAD VALVE MANUFACTURING COMPANY
P. O. BOX 21 *"Serving Since 1892"* CORAOPOLIS, PA., U.S.A.

the Ross Carrier Division of Clark Equipment Co.

The machine has a rated capacity of 10,000 lbs and is the only carrier available designed for that rating. It replaces Clark's previous model Series 70 and incorporates several major improvements.

Operator visibility and comfort have been increased by moving the driver's seat to the center of the machine, instead of over the rear axle, and lengthening the wheelbase to 90 in., 14 in. longer than the previous model.

Use of the syncromesh transmission, with three speeds both forward and reverse, eliminates all remote shifting linkage. Control levers are the direct type.

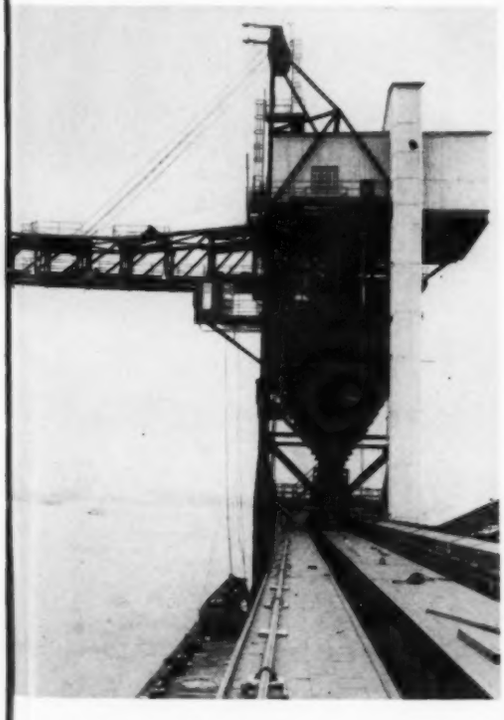
Hoist mechanism consists of a simple lever and link system actuated by a double-acting hydraulic cylinder. Hoist speed has been increased to 2.8 seconds, 50 per cent faster than the previous model. Rigid load hooks have been lengthened to 117 in. for improved load distribution; flared ends provide easy entry over the load.

Radi-arc steering gives the Series 71 the shortest turning radius of any carrier now available, the manufacturer says. Hydraulic brakes, 17¼ in. × 4 in., control the drive wheels. A mechanical parking brake is connected to the driveshaft.

Greater accessibility for engine maintenance has been acquired through inclusion of a one-piece hood which, when folded back, exposes the whole engine. Redesigned metal work gives the carrier clean-lined styling.

UNLOADING TOWER

A traveling coal unloading tower with a built-in elevator for maintenance and operating personnel and tools, has been designed and built by the Mead-Morrison Division of the McKiernan-Terry Corp. The tower is equipped with a 10-ton capacity lightweight grab bucket, with a free-digging rate of 850 tons per hour. A 150-ton receiving hopper, enclosed on the top, sides and rear, is built into the tower. A liquid spray system is used to suppress coal dust. The tower is 136 ft high above the dock rails and straddles a 21-ft high conveyor structure. Variable voltage control is used. The tower will travel 240 ft on the runway along the dock.

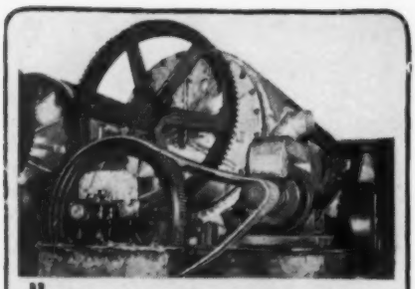


FILTER PROCESS

▲ A process developed by Wheelabrator Corp. for super cleaning atmospheric air with industrial-type air filtration equipment is announced.

The process called Ultra-filtration, may be used in applications formerly employing disposable or viscous fil-

WAUNAKEE
"TRANTINYL" ALLOY STEELS
the Key to
greater efficiency
in STEEL MILL
PRODUCTION
mill guides
"TRANTINYL"
QUALITY
DISTINCTION
"WAUNAKEE" is the sole licensee for the mid-west, west and south areas, to cast "TRANTINYL" Wear and Heat-Resistant Tools for the Pipe and Rolling Mills.
"TRANTINYL" quality is well-known . . . 20 years of dependable service to the steel industry.
Your order or inquiry will receive prompt attention
WAUNAKEE ALLOY CASTING CORP.
WAUNAKEE, WISCONSIN
W-1



"THIS LUBRICANT INCREASED CHAIN LIFE 4 TIMES"

—says FASTERFAT, Division of National Sea Products Limited

"Two years ago we switched from the lubricant we were then using to your LUBRIPLATE, and we are pleased to inform you that we have had very excellent satisfaction from its use. High speed silent chains on the drives of our fish meal cookers, which were formerly worn out in about six months, are still in service after two years."

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

LUBRIPLATE is available in grease and fluid densities for every purpose... LUBRIPLATE H. D. S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

ters or low voltage electrostatic precipitators. The advantages lie in extremely high cleaning efficiency, moderate cost, and nearly complete freedom from maintenance expense.

Briefly, the process involves the charging of the filter bags with a filter aid which precoats the filtering surfaces and provides a highly efficient matrix upon which the fine particles of atmospheric dust and tarry matter are collected. One application of filter aid will last from two to three years under normal conditions. Since shaking the spent filter aid and accumulated dust from the filter bags comprises the only maintenance of the filter required, maintenance costs are limited to the infrequent cleaning and recharging of the collector.

In one operating installation employing Wheelabrator Ultra-filtration having a design volume of 720,000 cfm of city air, the process reduces the dust content of the air from 5.21 to .04mgs, per 1000 cu ft. These figures are average values over a period of one year and indicate a collection efficiency against fine atmospheric dust of 99.23 per cent.

The efficiency of the process against extremely fine atmospheric dust and tarry matter is substantially greater than that of any previously used general air cleaning device. The cost compares very favorably to conventional devices having cleaning efficiencies as much as 30 per cent less than the new process. The maintenance cost is limited to the removal and replacement of spent filter aid at intervals as great as three years.

PINHOLE DETECTOR

▲ A redesigned pinhole detector for strip steel with a sensitivity five times greater than the former model has been announced by General Electric Co.

Under actual operating conditions on cold rolled strip steel, the new model will detect holes down to one millimeter diameter in opaque strip measuring 10 millimeters or less in thickness.

The new model, according to company engineers, will function with maximum sensitivity at strip speeds up to 2000 fpm. Laboratory tests, they said, indicate a potential in excess of 6000 fpm.

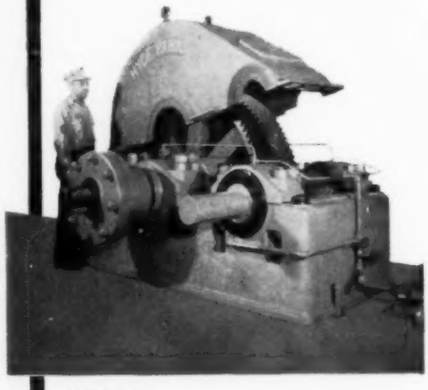
The former model provided effi-

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Hyde Park Castings up to 80,000 pounds are sound, accurate and physically dependable.
Precision machining is done by skilled craftsmen in our modern machine shop.
Send your blue prints for quotation.



Mill Drive

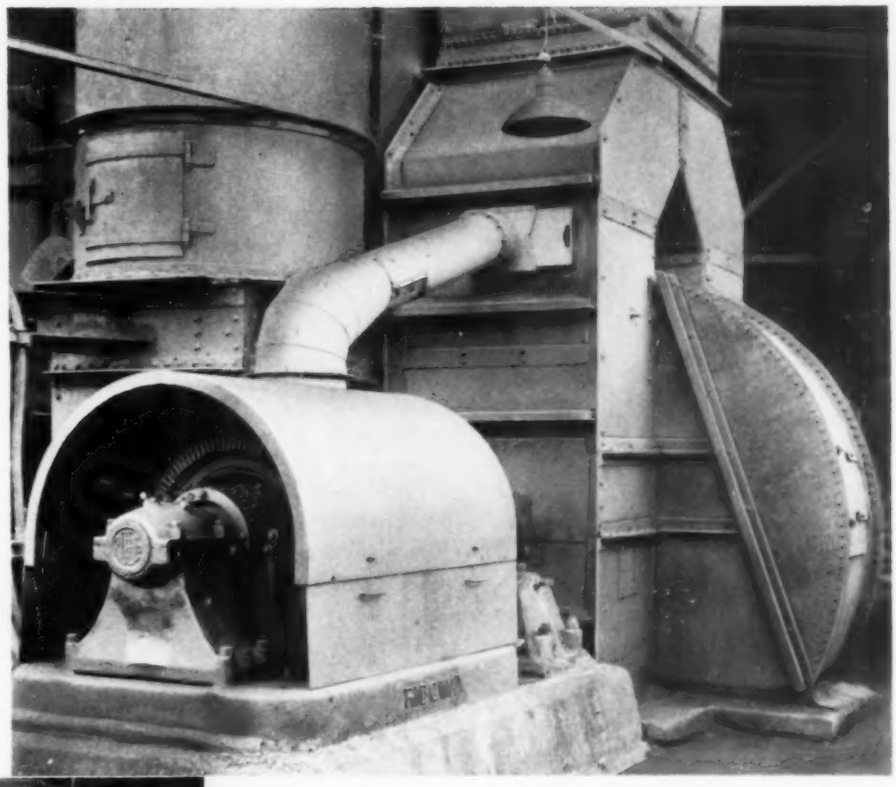
Machine Castings
Lathe Beds
Housings
Pinion Housings
Mill Housings
Shoe Plates
Layout Plates
Surface Plates

For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

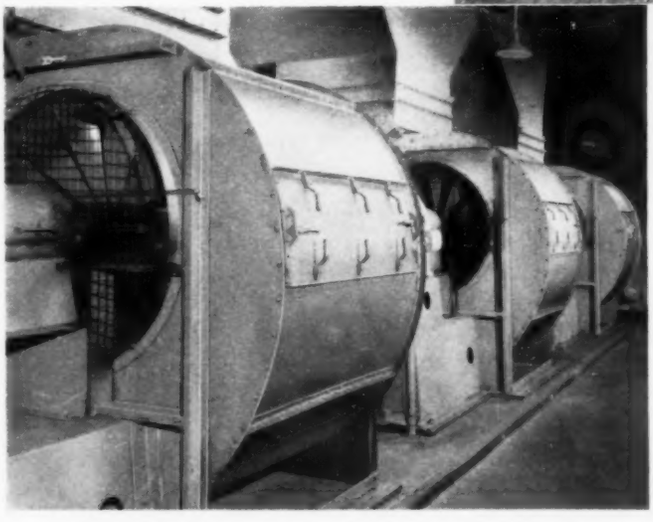
FOUR "Buffalo" SINTERING FANS HAVE SERVED JONES & LAUGHLIN 35 YEARS

Sintering is one of the toughest jobs you can hand a fan, because of the continual heat and abrasion of the flue gases it must handle. This is why the four "Buffalo" Fans installed in the Sintering Plant of Jones & Laughlin Steel Corp., Aliquippa Works in 1920 illustrate so well the economy of good maintenance plus "Buffalo" long-life construction.



RUGGED STRENGTH PLUS SERVICEABILITY

are built into these "Buffalo" Fans. Strength — to stand up under maximum periods of punishment; and servicibility for speed and ease of maintenance. Housings and rotor blades are heavy plate. Shafts and hubs are oversize; bearings, extremely heavy-duty. And "Buffalo" bolted sectional housing with quick-opening clean-out doors, provides accessibility.



The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

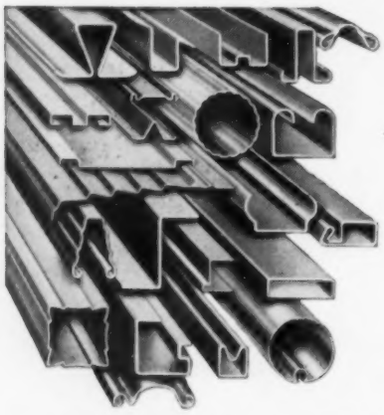
NEW "BUFFALO" MILL MOTOR FANS AT JONES & LAUGHLIN

These fans take the punishment of continuous operation in cooling the main mill motors on the new Blooming Mill at Aliquippa Works. They are "built up to the job" with all the high-strength, high-efficiency features the service calls for — in short, the famous "Q" Factor* built into all "Buffalo" Fans. Why not write today for details on the fan for greatest economy and longest life on your air job.

BUFFALO FORGE COMPANY
173 MORTIMER STREET BUFFALO, NEW YORK
PUBLISHERS OF "FAN ENGINEERING" HANDBOOK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



cold roll forming

FOR THE

GROWING BUSINESS

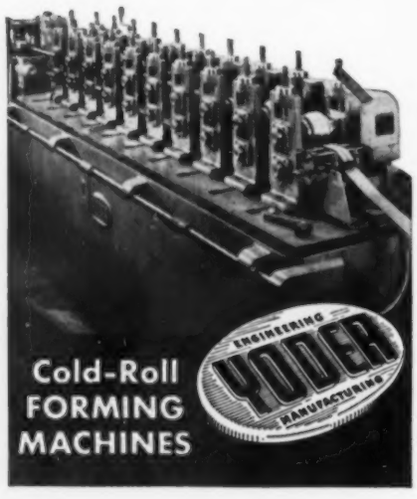
● As your business grows, new opportunities arise for drastic cost reduction by cold roll forming. For instance, you can make plain structural angles, channels, etc., up to ½" thick . . . light, strong, finely finished, at a substantial saving . . . You can form wide sheets and panels into cabinets for refrigerators, ironers, radio-TV sets, etc. . . . You can make nearly all components for metal buildings, including trusses, studs, joists, siding, roofing, windows, doors, mouldings, etc.

You can do perforating, notching, embossing, curving, coiling, etc., of the roll formed shapes, at no extra labor cost, by inexpensive extra tooling or attachments to the roll forming machine.

The Yoder Book on Cold Roll Forming illustrates and describes these versatile machines, typical end uses of roll formed shapes, how they reduce cost and increase production. A copy is yours for the asking.

THE YODER COMPANY

5495 Walworth Avenue, Cleveland 2, Ohio



cient operation at strip speeds up to 1500 fpm and had a sensitivity to five millimeters. G. E. noted that under ideal laboratory conditions the new model will detect holes as small as one-half millimeter in opaque strip.

A significant feature of the new design is a more than 10-fold increase in the light source—made possible by replacing an array of 21 small projection lamps with a single mercury vapor lamp. Comparative figures are a 2000-ft-candle output with the array of projection lamps and more than 25,000 ft-candles with the new single light source.

For improved diffusion of light, the detection chamber has been coated with a highly reflective white finish and equipped with six photo-multiplier tubes placed at strategic intervals. The former model had 30 tubes to do the same job.

Pre-selection of the photo-tubes is not necessary. Each tube is provided with a small neon light source which can be energized, and a sensitivity adjustment is provided on the end of the assembly for each photo-tube.

As a result of this arrangement, any standard photo-tube can be used and matched in place with the others.

Book Reviews . . .

"Good Painting Practice," Volume 1, and **"Systems and Specifications,"** Volume 2, prepared by a staff of specialists under the editorship of Joseph Bigos, has recently been published by Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh 13, Pa. This work was started in 1949 by the AISC who sponsored a national council for the purpose of research on surface preparation and the painting of steel structures and for the preparation and distribution of specifications and recommendations of standard practice in the cleaning and painting of structural steel. This committee's findings have resulted in a report of current practice outlined in these two manuals. To obtain information, comprehensive questionnaires on surface preparation and paint systems were mailed to many companies and groups. The replies indicated that there was a wide divergence in current practice, but also that there were many paint systems from which satisfactory results could be expected. These replies were used

Specify Adalet for

Sali insulating bushings

Assure trouble-free wiring of:

- **conduit runs**
- **outlet boxes**
- **electronic equipment**
- **control cabinets**
- **switchboards**

Precision machined from phenolic material, NEMA Class XX, Adalet insulating bushings are available for pipe sizes from ⅛ inch through 6 inches. Can be used on rigid or thin-wall conduit terminals, junction boxes, control cabinet knockouts, etc.

Mechanically and dielectrically strong . . . moisture and oil resistant. Send for sample or:

Request Bulletin A

THE Adalet MFG. CO.
14300 KOBAIN • CLEVELAND 11, OHIO

Bailey Recorder for receiving pneumatic and electric signals.

Pick any four, plug in, and record

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

Measured Variables

- % combustibles
- combustion
- conductivity
- density
- differential
- draft
- flow
- liquid level
- % oxygen
- pH
- position
- pressure
- ratio
- smoke density
- specific gravity
- speed
- temperature
- vacuum

P333-1

★

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
- Minimum instrument investment for process cycle expansion or alteration

BAILEY METER COMPANY

1047 IVANHOE ROAD

CLEVELAND 10, OHIO

Controls for Power and Process

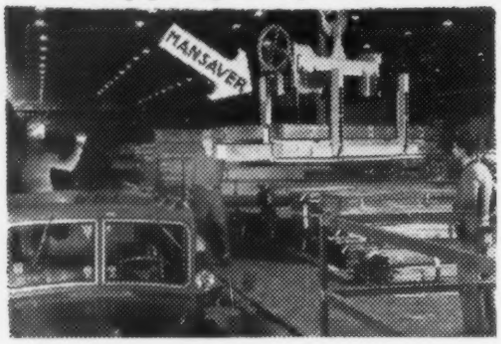
BAILEY METERS

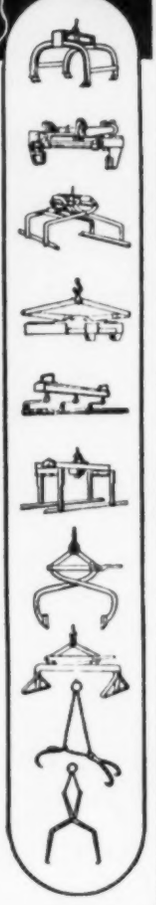
Controls for

TEMPERATURE
PRESSURE
GAS ANALYSIS
FLOW · LEVEL
RATIO · DENSITY

MANSAVER GRABS®

In Shipping Departments

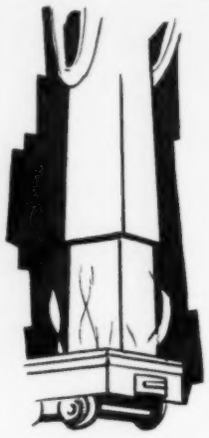




Your shipping department, too, can use Mansaver Grabs to advantage. With wide adjustment of size, high capacity, and unequalled safety, Mansavers like the one shown above repay their cost over and over. Mansaver Grabs, hand-operated or motor-driven, are supplied for sheet, bar, and coil handling.

Write for name of nearest representative, who will be glad to show how this applies to **your** plant.

MANSAVER INDUSTRIES, INC.
3116 EAST ST. • NEW HAVEN, CONN.



want IMPROVED Ingot surface quality?
THEN SPECIFY

DARMOLD
INGOT MOLD COATINGS

Liquids — Aluminum Base
Dry Powder — Powder-Water Mix

. . . you'll SAVE
DOLLARS
on steady Ingot Production

- High volatile content repels splashes, improves surface quality.
- Film-like coating keeps ingot surface free from impurities.
- Reduces costly "stickers" and lessens rejects.
- Applied by conventional methods.
- No mixing required — for liquids.
- Odorless vapors — approved by Medical and Safety Department.

JONES & LAUGHLIN STEEL CORPORATION
ALIQUIPPA PLANT
is a user of Darmold Ingot Mold Coating

Dacar Chemical Products Co.

Also manufacturers of FERRO-PLAST COATING for stools, ladles and thimbles.

McCARTNEY ST. — PITTSBURGH 20, PA.

FAST···LEGIBLE BILLET MARKING!

now made possible with the *NEW*

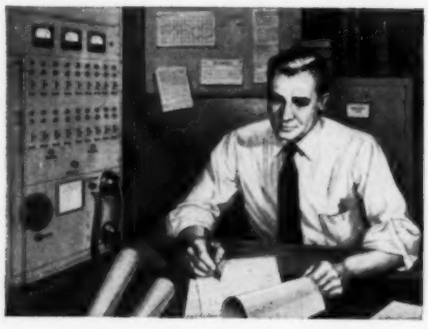
MODEL 701
PNEUMATIC
BILLET MARKER

This new, compact unit stamps ends of billets 4" x 4" or larger with a deep, legible mark as shown above. Unit is mounted on an I-beam track and powered by heavy duty air cylinder. Quick change type holder is kept in stamping position at all times without special guides.

WRITE for complete data.

Mecco SAFETY MARKING TOOLS — **M.E.CUNNINGHAM CO.**
1041 CHATEAU STREET, PITTSBURGH 33, PA.

CONTROL and COMMUNICATION



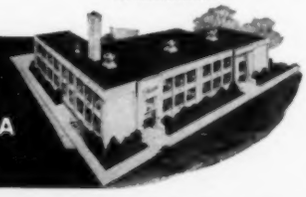
REMOTE CONTROLS
For overhead cranes, circuit breakers, pumps, fans, rectifiers, substations, etc.

FOR MODERN INDUSTRY

Femco's engineering knowledge serves industry. Remote control and voice communication systems are designed to solve any industrial problem.

TROLLEYPHONES
Voice communication between crane cabs and floor, mine locomotives and dispatcher.

AUDIOPHONES
Wired voice systems installed anywhere in industry. Common talking or selective.



Femco Inc.
IRWIN, PENNSYLVANIA
UNderhill 3-3200

Engineers and Manufacturers of Electronic Systems

in the preparation of the first manual. In general, Volume 1 consists of chapters describing current good surface preparation and painting practice in each industry covered. The authors of each chapter are experts in their field.

The second volume was published to fulfill the need for specific recommendations for the painting of various types of steel structures. The book is aimed at those with a limited knowledge of painting, yet who must make recommendations for the painting of structural steel. It will serve as a valuable check for those experienced in painting of steel to compare their conclusions with general good practice. These specifications cover nine basic paint systems which include approximately forty primers, nine surface preparations, four pretreatments, and many intermediate and finish coats. These systems normally cover every painting problem encountered.

Volume I consists of 423 pp., Volume 2 consists of 292 pp., both books being cloth bound, measuring 8½ x 11-in., price of each volume is $6 and when bought together, the price of both is $10 for non-members of the council.

"Industrial Furnaces," Volume II, by Professor W. Trinks, was recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 358 pp., 6 x 9-in., cloth bound and sells for $10. This is a highly recommended book, published as a third edition, and discusses practically everything needed for efficient furnace operation. A general breakdown of its contents includes fuels and electric energy, combustion devices and heating elements, control of furnace temperature, control of furnace atmosphere, labor saving appliances, critical comparison of fuels and of furnace types, and safety measures. Many important changes have been incorporated into this book over its previous editions. It is perhaps the best book on this subject for engineers and operators in the iron and steel producing industry and is listed on "The AISE Bookshelf."

(Please turn to page 276)

MAXIMUM
motor and
generator
PERFORMANCE
with

FLOWER

BRUSH HOLDERS

TANDEM
for slip ring service

TYPE 85-SK
for stationary motors
and generators

There's a reason for the claim: "maximum motor and generator performance" – long life for both Brush Holders and Brushes is built into the units with highest quality bronze castings, precision machining – proper designing.

Known throughout industry for their enduring qualities, some of these units have lasted more than 24 years, under critical operating conditions. High resistance to vibration and wear assures you, your FLOWER BRUSH HOLDER will not cause breakdowns in production.

GET COMPLETE INFORMATION NOW!

WRITE FOR CATALOG 4-I

FLOWER

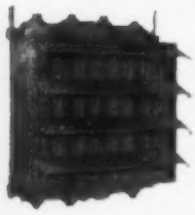
D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penna.

GRID UNIT HEATERS

installed in the CENTRAL STOREROOM

ALIQUIPPA WORKS!



. . . JUST ONE OF THE LOCATIONS WHERE GRID UNIT HEATERS ARE INSTALLED IN ALIQUIPPA WORKS, JONES & LAUGHLIN STEEL CORP.

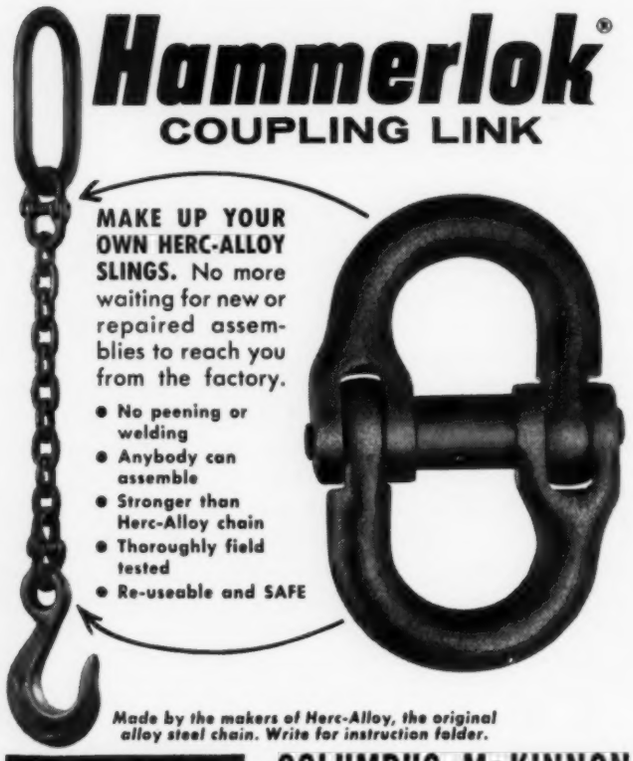
Jones & Laughlin Steel Corp. like many other major steel mills have turned to GRID for relief from the continuous expense of heating failures experienced with ordinary unit heaters. GRID Unit Heaters installed in steel mills in 1929 are still operating today . . . without maintenance or repairs. No other unit heater can approach this record because GRID'S All-Cast construction having similar metals in contact with steam prevents electrolytic corrosion. GRID'S ability to withstand steam pressures up to 250 p.s.i.

GRID'S low outlet temperatures, proper fan sizes and motor speeds assure delivery of warm, comfortable air in ample volume directly to the working level, where it is needed . . . no stratification of warm air at the ceiling to waste your fuel dollars. There are units cheaper than GRID, but there are none better. You start saving money the day you install GRID Unit Heaters.

Write today for the complete GRID story. Also, ask for complete information on GRID Blast Coils (Catalog BC-1049). Ask for booklet "CORROSION IN UNIT HEATERS" . . . it's yours upon request.

D. J. MURRAY MANUFACTURING CO
Manufacturers Since 1893 WAUSAU · WISCONSIN

Hammerlok®
COUPLING LINK



MAKE UP YOUR OWN HERC-ALLOY SLINGS. No more waiting for new or repaired assemblies to reach you from the factory.

- No peening or welding
- Anybody can assemble
- Stronger than Herc-Alloy chain
- Thoroughly field tested
- Re-useable and SAFE

Made by the makers of Herc-Alloy, the original alloy steel chain. Write for instruction folder.

CM HOISTS AND CHAIN

COLUMBUS McKINNON CHAIN CORP.
TONAWANDA, NEW YORK
Regional Offices:
NEW YORK • CHICAGO • CLEVELAND
In Canada: McKinnon Columbus Chain Ltd., St. Catharines, Ont.
HERC-ALLOY®

I Wish . . .

to enter one year's subscription for the IRON AND STEEL ENGINEER at $7.50 per year:

☐ Check enclosed
☐ Bill me later

I desire information on membership in the Association of Iron and Steel Engineers:

☐ Application blank
☐ Data

Name_____

Title_____

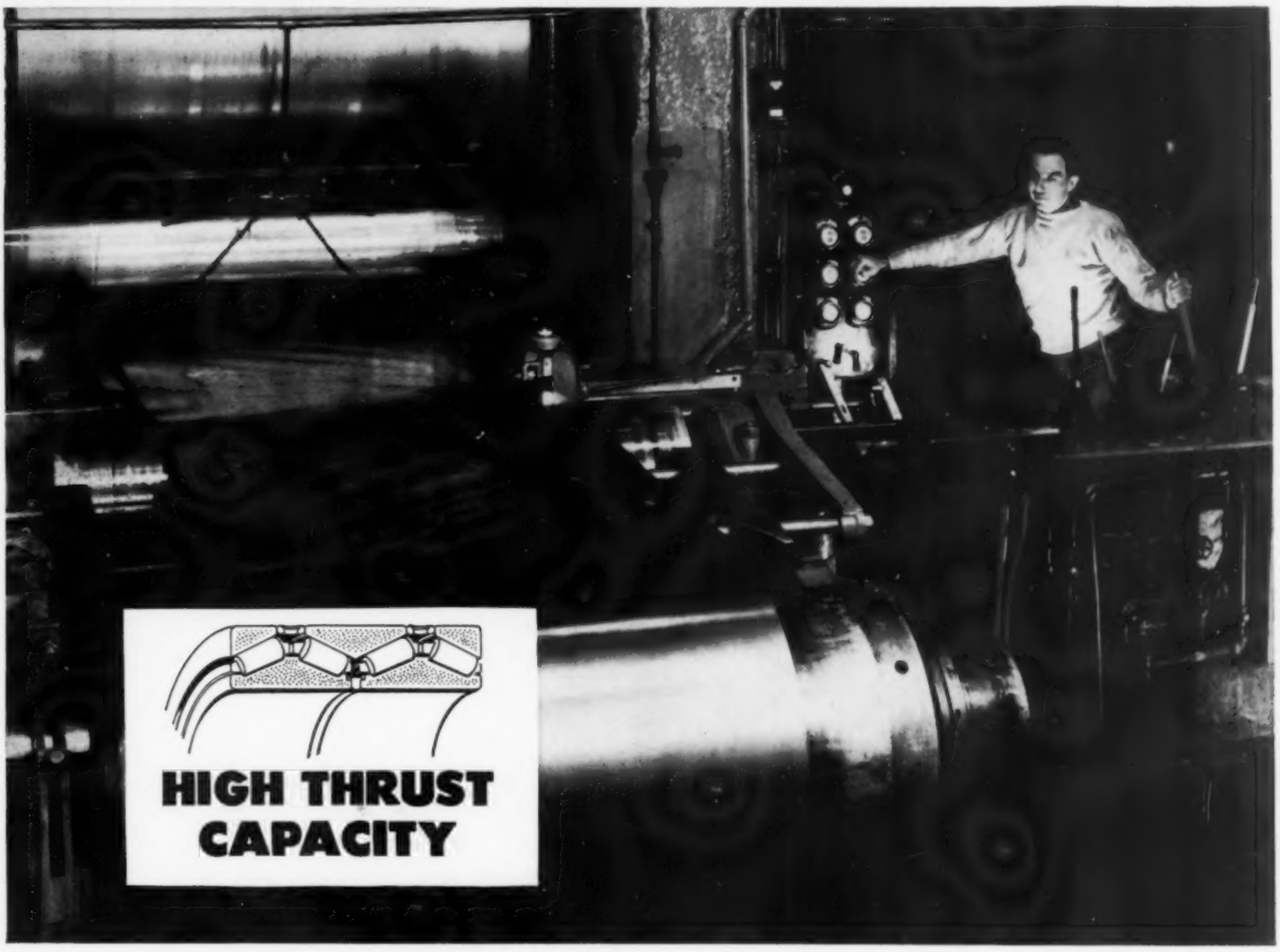
Company_____

Mailing Address_____

Mail this coupon to:

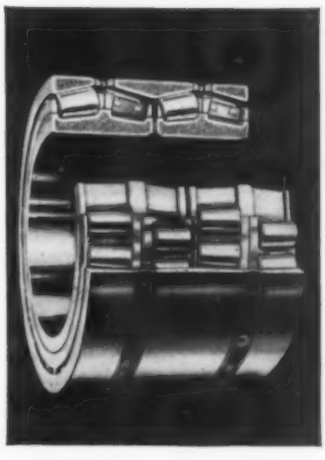
Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Penna.

IN THE STEEL INDUSTRY, TORRINGTON *Bearings are used extensively on work rolls, back-up rolls and for many auxiliary applications such as drives, pinion stands, coilers, etc.*



TORRINGTON Work Roll Bearings

are designed with steep angle construction to guarantee high thrust capacity under all operating conditions



High thrust capacity is just one of the many features of these bearings which have helped to establish many tonnage records.

TORRINGTON WORK ROLL BEARINGS are made of electric furnace alloy steels, carburized and heat treated to give maximum toughness, hardness, stability and uniformity.

One-piece, cast-bronze cages—with machined pads in each roller pocket—reduce wear, lengthen bearing life and improve tonnage performance.

Precision tolerances and finishes assure low eccentricity and cut friction to a minimum.

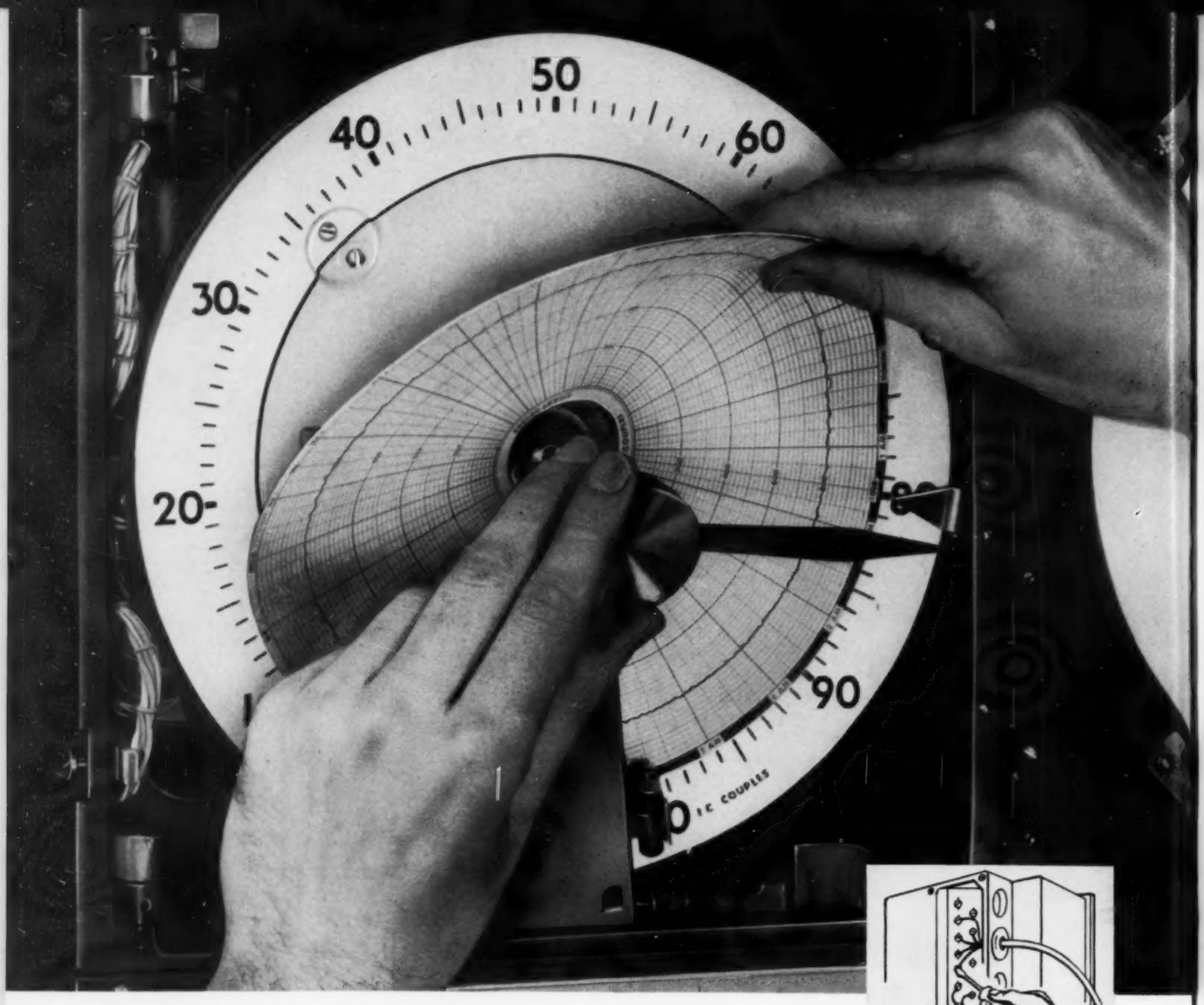
Specify TORRINGTON WORK ROLL BEARINGS in your rolling mill equipment. Many sizes—both two-row and four-row types—are available from stock for immediate shipment.

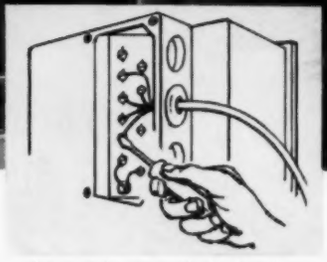
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

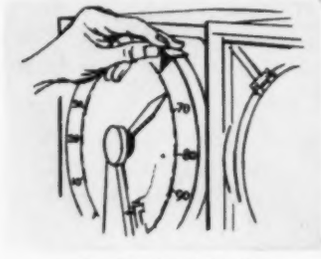
TORRINGTON TAPERED ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers





To put in operation, simply connect leads to back of case . . .



. . . set control point setter . . . turn on power switch.

A new concept in . . .

operating ease

WITH SPEEDOMAX® H

Although this round chart Speedomax H is small in size, you can set the control point or read it from a distance almost as easily as "big" instruments. For the easy-to-see control and indicating pointers travel around a large 23-inch scale. Chart changes take less than a minute!

All wiring connections are made to an external terminal board, at rear of the case. If you move the instrument from job to job, range changes can be made on the spot. A screw driver is the only tool you need.

Whether you're using a simple indicator or a 3-action controller, all components are in one compact unit. Relays, amplifiers, etc., have plug-in connections.

In short here's a complete line of null-balance potentiometers available for a broad-range of temperature measurements including many now being made with non-potentiometer instruments.

To see the features of this new line, get our pictorial fold-out. Phone your nearest L&N office or write us at 4942 Stenton Ave., Phila. 44, Pa. and ask for Die-Out ND46(1).

LEEDS NORTHRUP
instruments automatic controls • furnaces

VICTOR R. BROWNING MILL TYPE CRANES TO SPECIFICATION...

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.

WILLOUGHBY (CLEVELAND), OHIO

DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

Wagner®
CRANE-BRIDGE BRAKES
...the choice of leaders in industry

131 CRANES
at Aliquippa... all equipped with Wagner
Hydraulic Crane Brakes

There are 131 overhead traveling cranes in operation at Jones & Laughlin's Aliquippa Works and *all* of them are equipped with Wagner Hydraulic Crane Bridge Brakes.

This is because J&L is interested in safety, economy, and ease of crane brake operation. J&L has found that Wagner crane bridge brakes rank high in these three considerations.

The 75-ton Bessemer crane shown here is equipped with Wagner *Powered* Hydraulic Crane Bridge Brakes. These brakes are:

SAFE because cranes can be controlled without bridge motor plugging which causes damage to both motor and gears. Parking brakes can be set automatically in case of power failure.

ECONOMICAL because operators are less likely to drag *powered* brakes. There's less wear on wheels and lining . . . life of equipment is prolonged. Several brakes can be operated from one pedal so it's easy to step up production.

EASY-TO-OPERATE... tip-toe braking... finger-tip parking . . . one-minute bleeding.

Wagner power units can be added to your present Wagner Hydraulic System. Only six weeks are required to fill the average order. Bulletin 1U-36 gives full details—write for your copy today.

Type H or HM2 Brake Unit

Hydraulic power unit driven by totally-enclosed motor

Wagner Electric Corporation EST. 1891

WAGNER ELECTRIC CORPORATION
6403 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

155-3

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
P. O. Box 750 — 812-813 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 4-0417

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., Chicago 4, Illinois — 141 West Jackson Blvd. Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
"Cleveland" Worm Gearing and Worm Gear Speed Reducers — 28 Years
THE FARVAL CORPORATION
"Farval" Centralized Lube Systems—28 Years
LUBRICATION PRODUCTS COMPANY
"Strapax" Journal Box Lubricator — 22 Years
AMERIGEAR-ZURN, INC.
"Amerigear" Flexible Couplings — 7 Years
WALDES KOHINOOR, INCORPORATED
"Truarc" Retaining Rings — 9 Years
2400 W. Clybourn St. — Phone:
Milwaukee 3, Wisc. — Division 2-7844

PITTSBURGH DISTRICT

CHEMSTEEL CONSTRUCTION COMPANY, INC.
204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
Send data on Engineering & Construction facilities for
ACID-ALKALI-PROOF CONSTRUCTION
of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

RITTER ENGINEERING CO.
Engineers • Distributors • Contractors
1515 W. LIBERTY AVE. — Phone
PITTSBURGH 26, PA. — LOCUST 1-1303
TRABON—Centralized Lubricating Systems
METERFLO—Circulating Oil Systems
PARKER—Hydraulic & Fluid System Components
"Specialists in Lubrication and Hydraulics"

PITTSBURGH (Continued)

W. G. KERR CO., INC.
520 Oliver Building — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and SpeedReducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

SARGENT ELECTRIC COMPANY
Electrical Construction
410 First Avenue
Pittsburgh 19, Pa.

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building — PITTSBURGH, PA.
COurt 1-7032

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
STEEL MILLS—INDUSTRIALS UTILITIES
313 EAST CARSON ST. — ZONE 19

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

PITTSBURGH (Continued)

AUBURN AND ASSOCIATES, INC.
ENGINEERS
COMPLETE
ENGINEERING . DESIGN . LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

CONSULTING ENGINEERS

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue — Chicago 49, Illinois
Telephone SAginaw 1-3466

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Electrical Engineers
Engineering • Design • Layout
Heavy Industrial Power & Light
Frederick Building .. Cleveland 15, Ohio
Prospect 1-2060

Hickory-9-5141 — DETROIT, MICH.
WHITMORE LAKE, MICH. — WOodward 3-8706
LOYAL R. MILBURN
Hangsterfer's Laboratories Inc.
Drawing and Cutting Compounds for Stainless Steel, Chrome Nickel and Titanium
Residence: — Office:
WHITMORE LAKE, MICH. — 1928 Guardian Bldg. DETROIT 26, MICH.

HOUSER AND CARAFAS ENGINEERING CO.
Engineering for Industry
4 Smithfield Street -:- Pittsburgh 22, Pa.
Phone: GRant 1-9929

MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street — Millersville, Pa.
Tel. 6153
Steel Industry Representative for
CHEMICAL CONSTRUCTION CORPORATION
P-A- VENTURI SCRUBBER
Cleaning Blast Furnace, Converter, Open Hearth and Scarfing Gases. Bulletins Available.

THE ENGINEERING MART
(CONTINUED)

CONSULTING ENGINEERS

EDWARD WINTERHALTER, P. E.
Basic Surveys, Plans and Design
Specifications • Performance Development
for
Electrically Powered and Controlled Facilities
Electric Power Supply & Distribution Systems
Chestnut Ridge Road — Coshocton, Ohio
Route 3 — 2483 W-2

ENGINEERING SERVICE BUREAU
Structural • Mechanical • Electrical
Plans • Design • Layout
BEN MACCABEE — 173 W. Madison St. CHICAGO 2, ILL.

INDUSTRIAL
FURNACE COMPANY
Engineers and Builders of:
Soaking Pits
Reheating Furnaces
Annealing Furnaces
Heat Treating Equipment
SALEM, OHIO
EDgewood 2-4618

PRODUCTS

POSITIONS VACANT

MAINTENANCE ENGINEER or GENERAL MASTER MECHANIC

Age 38 to 45 with 15 years experience in heavy Steel Plant maintenance-technical education or practical equivalent. Supervisory ability, knowledge of maintenance trades necessary. Permanent position with Eastern Penna. Steel Company. Send resume, salary expected to Box 1101 IRON AND STEEL ENGINEER, 1010 Empire Bldg., Pittsburgh 22, Pa.

SALESMAN WANTED

For Chicago territory by well established manufacturer of Refractories to sell steel mills. Must have knowledge of refractories or steel mill selling experience. Salary and expenses. Box 1102, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

ENGINEERS — ALL GRADES
Mechanical, Structural, Civil
for
Design, Liaison, Supervision, Estimating
Experience in Engineering for
Steel, Aluminum, Nuclear Energy Plants or
General Development
Domestic and Foreign Location
CONTACT — PITTSBURGH OFFICE
KAISER ENGINEERS
Division of Henry J. Kaiser Co.,
Mr. Ray Fullerton, District Engineer
Phone ATlantic 1-7995 For Interview
or mail copy of experience record to Box No. 1103, Iron and Steel Engineer, 1010 Empire Building, Pittsburgh 22, Pa.
All replies held in confidence

Book Reviews

(*Continued from page 269*)

"Large Air Circuit Breakers," a recent NEMA Standard Publication is now available from National Electrical Manufacturers Association, 155 East 44th St., New York 17, N.Y. This standard contains five parts, 8½ x 11-in., paper bound and sells for $4.75. This is a revised standard which covers a-c breakers rated 600 volts and less and d-c breakers rated 3000 volts and less. Instructions are given for the installation, operation and care of such breakers, and the terms used throughout the text are defined.

"Diesel Engine Principles and Practice," written by 23 specialist contributors and edited by C. C. Pounder, was recently published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 820 pp, 5½ x 8½-in. and sells for $17.50. This volume is arranged in twenty-six sections covering the theory, construction and applications of diesel engines of all types. The first chapters of the book deal with theory and components of diesel engines followed by sections on torsional vibration, engine balancing and materials and crankcase explosions. Also described in this book are different types of engines beginning with vehicle and tractor engines and proceeding to engines for railcars and locomotives, air-cooled engines, stationary high speed engines, engines of moderate power and speed, dual fuel engines, and marine engines. The book is an over-all complete survey of the most up-to-date practice in diesel engineering and serves as a reference for engineers and students. Authors are British and much of the equipment described is British.

thanks to Christmas Seals!

Like a protective radar network, a barrier formed by Christmas Seals helps to guard us against tuberculosis.

The money which *you* donate for Seals fights TB the year round – with continuing medical research, education, rehabilitation, and case finding.

To keep the barrier high, send your contribution today, please, to your tuberculosis association.

Buy Christmas Seals

Because of the importance of the above message, this space is contributed by **IRON AND STEEL ENGINEER**

GUARD YOUR FAMILY
LEARN TO RECOGNIZE
CANCER'S DANGER SIGNALS

- Any sore that does not heal
- A lump or thickening in the breast or elsewhere
- Unusual bleeding or discharge
- Any change in a wart or mole
- Persistent indigestion or difficulty in swallowing
- Persistent hoarseness or cough
- Any change in normal bowel habits

Be on the alert for cancer's symptoms. They may not mean cancer — but they should always mean a visit to your doctor.

AMERICAN CANCER SOCIETY
GIVE TO THE CANCER CRUSADE

INDEX TO ADVERTISERS

NOVEMBER, 1955

A

Adalet Manufacturing Co. 266
Aetna-Standard Engineering Co. 1
Air Products, Inc. 252
Ajax Flexible Coupling Co. 239
Alliance Machine Co. 3
Allis-Chalmers Manufacturing Co. 8, 9, 42, 43, 221
American Air Filter Co. 255
American Flexible Coupling Co. 177
American Shear Knife Co. 269
Ampco Metal, Inc. 247

B

Bailey Co., William M. 254
Bailey Meter Co. 267
Bearings, Inc. 47
Bedford Foundry and Machine Co. 20
Berry Bearing Co. 2
Birdsboro Steel Foundry and Machine Co. 217
Bliss Co., E. W. 207
Bristol Co. 237
Browning and Co., Inc., Victor R. 273
Buffalo Forge Co. 265
Bussmann Manufacturing Co. 162, 163

C

Chandeysson Electric Co. 215
Cities Service Oil Co. 31
Clark Controller Co. 40
Cleveland Crane and Engineering Co. 32, 33
Cleveland Worm and Gear Co. 227
Columbus McKinnon Chain Corp. 270
Corhart Refractories Co. 160
Crane Co. 260
Cunningham Co., M. E. 268
Cutler-Hammer, Inc. Cover 2

D

Dacar Chemical Products Co. 268
De Laval Steam Turbine Co. 202
Diamond Power Specialty Corp. 196
Dingle-Clark Co., The 201
Documentation and Licenses, Paris, France 28, 29
Dowell, Inc. 182
Dravo Corp. 50, 165
Drever Co. 22
Duraloy Co., The 257

E

Electric Controller and Manufacturing Co. 48, 49
Electric Furnace Co., The 228
Electric Machinery Manufacturing Co. 240
Electric Service Manufacturing Co. 212, 213
Euclid Electric and Manufacturing Co., The 249
Exide Industrial Division, Electric Storage Battery Co. 190

F

Falk Corp., The 18
Farrel-Birmingham Co., Inc. 222
Farval Corp., The Cover 3
Femco, Inc. 268
Flinn and Dreffein Engineering Co. 28, 29
Flower Manufacturing Co., D. B. 269

G

General Electric Co. 13, 14, 15, 16, 230, 231
General Refractories Co. 25
Gulf Oil Corp. 174, 175

H

Hagan Corp. 52, 53
Hallden Machine Co., The 28, 29
Heyl and Patterson, Inc. 37
Homestead Valve Manufacturing Co. 262
Hunt and Son, Inc., C. B. 206
Hyatt Bearings Division, General Motors Corp. 218
Hyde Park Foundry and Machine Co. 264
Hydropress, Inc. 180

I

Industrial Gauges Corp. 191
Industrial Gear Manufacturing Co. 235

J

Johns-Manville Corp. 216

K

Koppers Co., Inc. 7, 38, 39, 233

L

Lawrence Copper and Bronze Co. 258
Leeds and Northrup Co. 272
Link-Belt Co. 30, 224
Lintern Corp., The 228
Lubriplate Division, Fiske Brothers Refining Co. 264

M

Mackintosh-Hemphill Division, E. W. Bliss Co. 208
Mannesmann-Meer Engineering and Construction Co. 176
Manning, Maxwell and Moore, Inc. (Shaw Box Division) 187
Mansaver Industries, Inc. 268
McDowell Co., Inc. 169, 170
McKee and Co., Arthur G. 186
McKiernan-Terry Corp. 214
Mesta Machine Co. 4, 5
Miles and Partner John (London, Ltd.) 28, 29
Minneapolis-Honeywell Regulator Co. 204, 205
Morgan Construction Co. 197
Morgan Engineering Co., The 232
Murray Manufacturing Co., D. J. 270

N

National Carbon Co., Division of Union Carbide and Carbon Corp. 54
National Roll and Foundry Co., The 248

O

Ohio Electric Manufacturing Co., The 236
Ohio Knife Co., The 34
Ohio Steel Foundry 194

P

Pennsylvania Engineering Corp. 256
Pennsylvania Transformer Co. 27
Pittsburgh Lectromelt Furnace Corp. 56
Pocahontas Fuel Co. 210, 211
Pollock Co., William B. 10
Poole Foundry and Machine Co. 278
Post-Glover Electric Co. 35
Pratt and Whitney Co., Inc. 198, 199

R

Radio Corp. of America 251
Refractory and Insulation Corp. 200
Reliance Electric and Engineering Co. 21
Roberts and Schaefer Co. 238
Rollway Bearing Corp. 242
Rust Furnace Co. 159
Rust-Oleum Corp. 17

S

Salem-Brosius Inc. 241
Selas Corp. of America 250
Spraying Systems Co. 181
Stamco, Inc. 228
Steel Plant Equipment Corp. 229
Sun Oil Co. 11, 12
Surface Combustion Corp. 44, 45
Sutton Engineering Co. 173
Swindell-Dressler Corp. 178, 179

T

Taylor Chain Co., S. G. 203
Taylor Instrument Co. 259
Texas Co., The Cover 4
Timken Roller Bearing Co., The Cover 1
Tool Steel Gear and Pinion Co. 188, 189
Torrington Co., The Bantam Bearings Division 271
Treadwell Co., Inc., M. H. 36

U

Union Carbide and Carbon Corp., National Carbon Co. 54
United Engineering and Foundry Co. 19
United States Graphite Co. 261

V

Vaughn Machinery Co., The 6

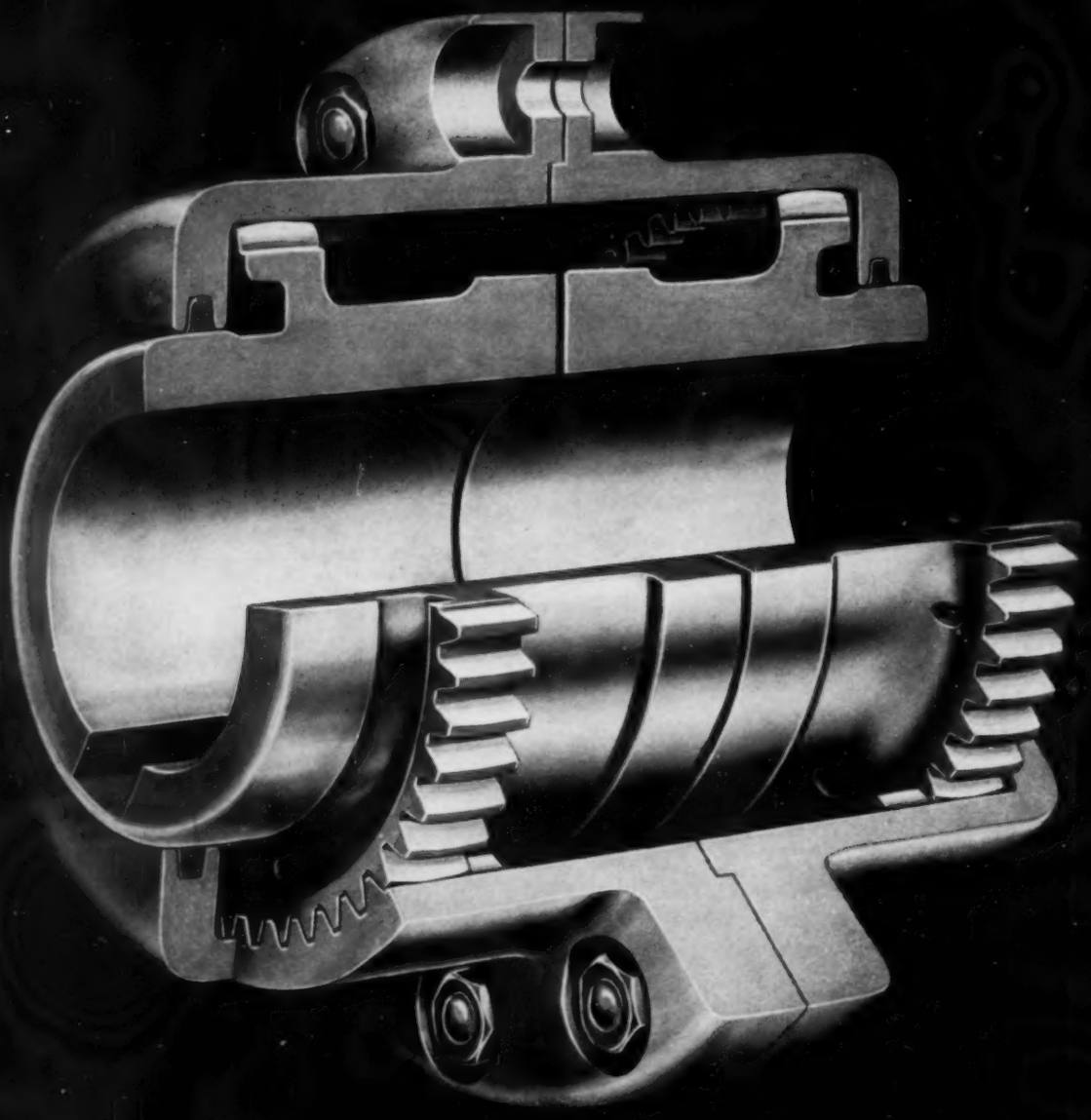
W

Wagner Electric Corp. 274
Waterbury Farrel Foundry and Machine Co. 209
Waunakee Alloy Casting Corp. 263
Wean Engineering Co. 28, 29
Wean Engineering Co., of Canada Ltd., The 28, 29
Wean Equipment Corp. 28, 29
Western Gear Corp. 41
Westinghouse Electric Corp. 192, 193
Wheelabrator Corp. 46
Wilson-Snyder Works, Oil Well Supply Division, U. S. Steel Corp. 234

Y

Yoder Co., The 266
Youngstown Alloy Casting Corp. 166, 167
Youngstown Welding and Engineering Co., The 226

POOLE

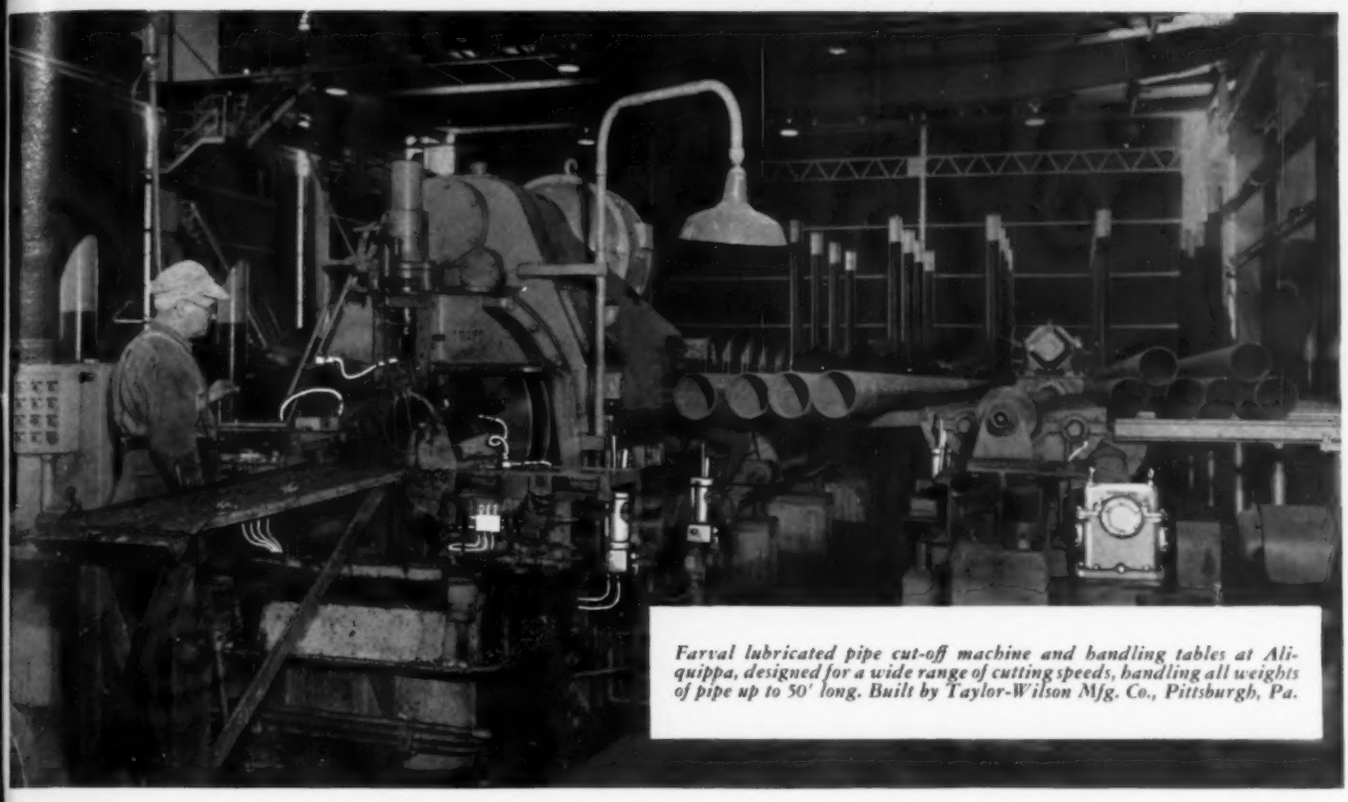


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

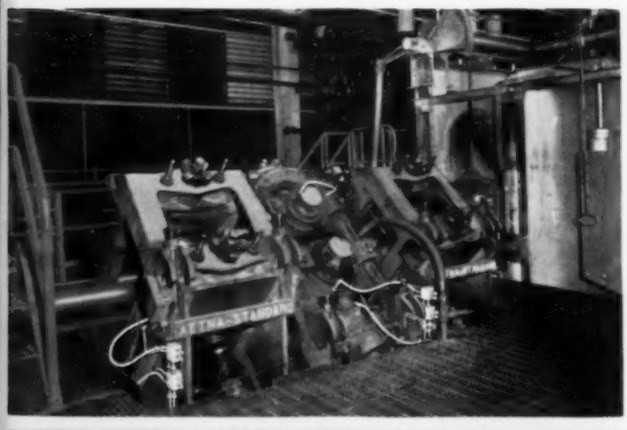
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.



Farval lubricated pipe cut-off machine and handling tables at Aliquippa, designed for a wide range of cutting speeds, handling all weights of pipe up to 50' long. Built by Taylor-Wilson Mfg. Co., Pittsburgh, Pa.

FARVAL lubricates cut-off and sizing machines for faster pipe production



Three-stand pipe-sizing mill at Aliquippa Plant of J & L, built by Aetna-Standard Eng. Co., Pittsburgh, and (below) the Farval DC4 system which lubricates it. This is a fully automatic, motor-driven, time-clock controlled system, serving 12 bearings on the sizing mill.

DESIGNED for high output of top quality products, the Jones & Laughlin pipe mill at Aliquippa employs scores of proven, modern methods and devices to streamline and speed production. One of these aids is Farval Centralized Lubrication.

Through Farval's assured protection of bearings, downtime for oiling and bearing repairs is eliminated. Farval contributes further to reduced costs through savings in oiling labor and lubricant.

The high speed cut-off machine and handling tables, built by Taylor-Wilson, for example, are lubricated by three Farval manual systems serving 270 points. The Aetna-Standard Sizing Mill is lubricated by another Farval Automatic System.

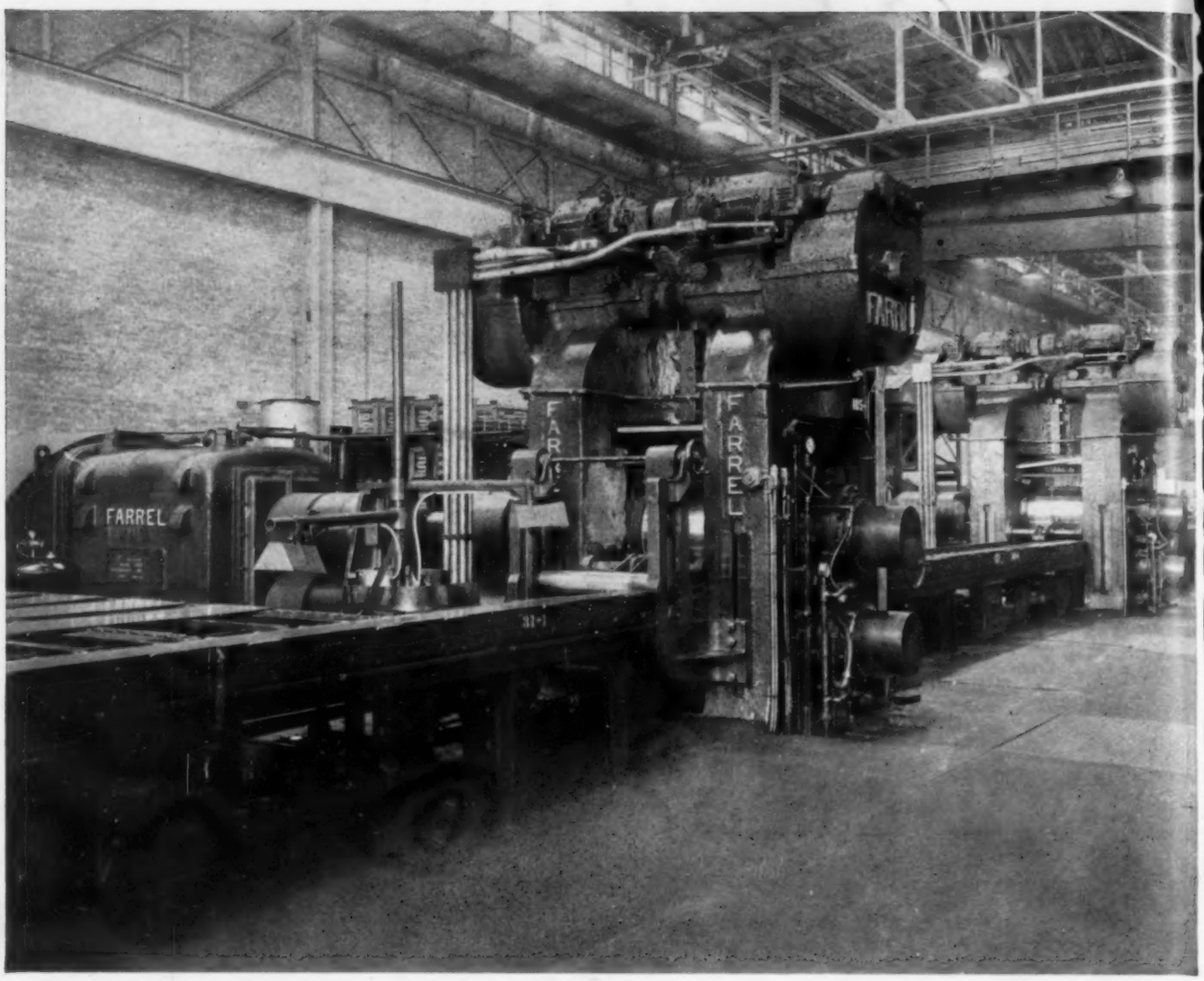
Other equipment in the Aliquippa Works, as well as in other J & L plants, is protected by Farval systems—more than a hundred systems in all, serving upwards of 10,000 bearings.

The Farval Corporation, 3278 East 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION



Add years to your gears . . .

ENCLOSED reduction gears and their bearings stay in service longer, run smoother, require less maintenance expense when you use *Texaco Meropa Lubricant.*

Texaco Meropa Lubricant is refined from the choicest base stocks, and further improved by highly effective and long-lasting EP agents. *Meropa* keeps gears operating dependably, even under shock loads and extra-heavy steady loads.

Other outstanding characteristics of *Texaco Meropa Lubricant* are its resistance to thickening at high operating temperatures, and its high oxidation resistance. In addition, *Texaco Meropa Lubricant* will not foam, is non-corrosive to bearing metals, and remains stable in use, centrifuging or storage.

You can assure highest efficiency at lowest cost by employing effective Texaco Lubrication. Let a Texaco Lubrication Engineer help you select the proper lubricants for your operation. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL GEAR DRIVES

TUNE IN . . . TEXACO STAR THEATER starring JIMMY DURANTE on television . . . Saturday nights, NBC.